MATERIA MEDICA

PHARMACY, PHARMACOLOGY

AND

THERAPEUTICS

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BY

WILLIAM HALE-WHITE, K.B.E.
M.D. Lond., M.D. Dub., (Hon.) Col. R.A.M.C. (T.)

CONSULTING PHYSICIAN TO GUY'S HOSPITAL
PRESIDENT, ROYAL SOCIETY OF MEDICINE;
EDITOR OF 'A TEXT BOOK OF PHARMACOLOGY AND THERAPEUTICS'
AUTHOR OF 'COMMON AFFECTIONS OF THE LIVER'

EIGHTEENTH EDITION

LONDON
J. & A. CHURCHILL
GREAT MARLBOROUGH STREET
1924

First Edition	1892
Second ,,	1897
Third ,,	1898
Fourth ,,	1899
Fifth ,,	1900
Sixth ,,	1901
Seventh ,,	1902
Eighth ,,	1903
Ninth ,,	1905
Tenth ,,	1907
Eleventh ,,	1909
Twelfth ,,	1911
Thirteenth ,,	1914
Fourteenth ,,	1915
Fifteenth ,,	1916
Sixteenth ,,	1918
Seventeenth ,,	1920
Eighteenth ,,	1924

PREFACE

TO

THE EIGHTEENTH EDITION

SEVERAL additions and alterations have been ma
in this edition with the object of increasing tl
usefulness of the book. An account of Insulin
included.

CONTENTS

MATERIA MEDICA

Materia Medica is so wide a term that it is difficult to define. It includes the following:

(*a*) Materia Medica proper, sometimes called Pharmacognosy. This is the knowledge of the natural history, physical characters, and chemical properties of drugs.

(*b*) Pharmacy.—This is the science and art of the preparation and combination of drugs, so as to render them fit for administration.

(*c*) Pharmacology.—This is the science which treats of the actions of drugs on the body both in health and disease. A subdivision of it is Pharmacodynamics, which is the science of the physiological action of drugs in health. The science which studies the effects of doses large enough to endanger life is Toxicology.

(*d*) Therapeutics is the science and art of alleviating or curing disease. Many authors do not include this under the term Materia Medica. Therapeutics is either—

(1) Rational. when we have sufficient knowledge of the disease and the pharmacological action of the remedy to know why it should be of benefit, *e.g.* The use of digitalis for mitral disease.

(2) Empirical, when our knowledge is insufficient to tell us why the remedy is efficient, *e.g.* The use of salicylates for rheumatic fever.

Therapeutics ought not to be included in the term Materia Medica, for that treats only of drugs; but Therapeutics, properly speaking, is concerned with all means of alleviation.

General Therapeutics is a subdivision of Therapeutics; it is the science and art of alleviating disease by such remedies as are not drugs, *e.g.* diet, climate, baths, venesection, and cupping. In this work we shall consider only that part of Therapeutics which is concerned with drugs.

A Pharmacopœia is a book published by some authorised body, generally constituted by law. This book describes most of the drugs in common use, and gives directions concerning the making of preparations from them. The pharmacopœias and the authorities publishing them differ in different countries. The **British Pharmacopœia** is published by the General Medical Council. The last edition appeared in 1914. As new drugs are discovered they are, if of sufficient use, included in new editions of the Pharmacopœia. Everything contained in the Pharmacopœia is said to be "official." The abbreviation for "British Pharmacopœia" is "B. P."

The Council of the Pharmaceutical Society of Great Britain have published a valuable book, "The British Pharmaceutical Codex," containing many preparations not in the "British Pharmacopœia." Some are mentioned in this book. When prescribed, B. P. C. should be put in a bracket after them.

MATERIA MEDICA PROPER.

As much of this as the student need know will be mentioned under each drug.

PHARMACY.

Pharmacy is for the most part carried out by the manufacturing and dispensing chemist. The medical student should, however, be acquainted with the simpler processes, as he may have to perform them. They are best learnt in the dispensary. An elementary knowledge of chemistry will enable him to understand most of the terms used in pharmacy, but the following should be noticed.

Alkaloids are bodies having the following characteristics:

(1) They are the active nitrogenous principles of organic bodies.

(2) They are compound ammonias: that is to say, one or more atoms of hydrogen in ammonia (NH_3) are replaced by various radicals.

(3) They combine with acids to form crystalline salts without the production of water.

(4) They are alkaline, turning red litmus paper blue.

(5) Very few are liquid, such as pilocarpine, coniine, nicotine, sparteine, lobeline. Liquid alkaloids nearly always contain only carbon, hydrogen, and nitrogen.

(6) The solid ones are colourless crystalline, and contain oxygen.

(7) They are sparingly soluble in water, readily so in alcohol.

(8) The solutions of many are intensely bitter.

(9) Most of them are closely related to pyridine, and some may be synthetically prepared from pyridine bases.

Names of alkaloids terminate in English in *-ine* (quinine), in Latin in *-ina* (quinina). Examples in B. P.: Atropine, Cocaine, Strychnine, &c. Except in the case of Aconitine, Atropine, Caffeine, Cocaine, Codeine, and Strychnine, salts of alkaloids, but not alkaloids themselves, are official. Morphine is, however, official in the Appendix to the Pharmacopœia.

Glucosides are crystalline bodies which when acted upon by acids, or chemical ferments (enzymes), split up into sugar (nearly always glucose) and other substances (alcohols, aldehydes, phenols, &c.), different in each case.

Example in B. P.: Salicinum. Many varieties of tannic acid exist in plants as Glucosides.

Saponins are a group of glucosides forming a clear solution in water, which froths on shaking, and may be used to emulsify oils and resins. Senega contains a powerful saponin.

Neutral Principles are indifferent proximate crystalline principles whose chemical characters have not been determined.

Example in B. P.: Aloinum.

Fixed Oils are ethereal salts formed from the higher fatty acids and the trihydric alcohol glycerin, $C_3H_5(OH)_3$. At ordinary temperatures they remain liquid. The usual fatty acids entering into the composition of fixed oils are oleic, palmitic, and stearic.

Example: Olive oil consists of a mixture of a combination of oleic acid ($C_{18}H_{34}O_2$) with glyceryl (C_3H_5) and palmitic acid ($C_{16}H_{32}O_2$) with glyceryl. That is to say, ordinary olive oil is a mixture of two oils having the formulæ $C_3H_5(C_{18}H_{33}O_2)_3$ and $C_3H_5(C_{16}H_{31}O_2)_3$ respectively. When acted upon by caustic alkalies or metallic oxides fixed oils form soaps (oleates, palmitates, or stearates of metals) and glycerin. This process is called saponification,

$$e.g.\ C_3H_5(C_{18}H_{33}O_2)_3 + 3NaHO = \underset{\substack{\text{Hard Soap} \\ \text{Sodium Oleate}}}{3NaC_{18}H_{33}O_2} + \underset{\text{Glycerin}}{C_3H_5(OH)_3}.$$

Fixed Oils are obtained from the fruits or seeds of plants, or from animal tissues, by expression or by boiling with water and skimming off the melted oil. When pure they usually are yellow, and float on water; they cause a greasy mark on paper. They are called fixed because they cannot be distilled without decomposition. They are soluble in ether or chloroform.

Liquid fixed oils in B. P. are Olea Amygdalæ, Crotonis, Lini, Morrhuæ, Olivæ, Ricini.

Fats are fixed oils which are solid at ordinary

temperatures; if extracted by expression sufficient heat to melt them must be used.

Examples in B. P.: Oleum Theobromatis, Adeps Preparatus.

Waxes are chiefly composed of fatty acids combined with monohydric alcohols homologous with methyl alcohol.

Volatile or Essential Oils only resemble fixed oils in being soluble in the same media. They do not leave a greasy mark on paper. They are mostly inflammable, and lighter than water. They are highly aromatic, and sufficiently soluble in water to impart their odour and taste to it. Most are prepared by distillation—that is, by passing a current of steam through the substance from which they are extracted, the steam is condensed, and the oil either floats to the top or sinks to the bottom of the water. A few, as oil of lemon, are obtained by expression from a fruit. Their composition varies very much. They contain Aldehydes (Cinnamic Aldehyde, in oil of cinnamon), Phenol derivatives (Eugenol, in oil of cloves), Esters or Ethereal Salts (Methyl Salicylate, in oil of wintergreen), Alcohols (Menthol, in oil of peppermint), or Ketones (Carvol, in oil of caraway), generally associated with Terpenes (*see* oil of turpentine) of varying composition, and which may be the chief constituent of the oil (*e.g.* the Terpenes in oils of turpentine).

Examples in B. P.: Olea Anethi, Anisi, Cinnamomi, Lavandulæ, &c.

Resins are very complex bodies. They are among the products of oxidization of volatile oils. They contain many indifferent substances and acids. They are soluble in alkalies, forming resin soaps. Hence the alkali in Decoctum Aloes Compositum, Tinctura Guaiaci Ammoniata, and Tinctura Valerianæ Ammoniata. They are insoluble in water, but not in

alcohol, therefore they may be prepared by extraction with alcohol and precipitation with water; also this is the reason for the precipitate which falls when water is added to a resinous tincture.

The B. P. resins are Resina, Resina Guaiaci, Jalapæ, Podophylli and Podophylli Indici.

Oleo-resins are natural solutions of resins in volatile oils.

Those in B. P. are Copaiba and Terebinthina Canadensis.

Balsams are mixtures of oleo-resins with benzoic acid or cinnamic acid, or with both.

Those in B. P. are Benzoinum, Balsamum Peruvianum, Balsamum Tolutanum, Styrax Præparatus.

Gums are exudations from the stems of plants containing one or more of:

(*a*) Arabin or soluble gums, *e.g.* Acacia.
(*b*) Bassorin or partially soluble gums, *e.g.* Tragacantha.
(*c*) Cerasin or insoluble gum.
Solutions of gum are precipitated by alcohol.

Gum-resins are exudations from plants consisting of a mixture of gums and resins. When they are rubbed with water the gum dissolves, and the resin remains mechanically suspended in the solution.

The B. P. gum-resins are Ammoniacum, Asafetida, and Myrrha.

An Emulsion consists of finely divided particles of an oil, fat, or resin suspended in a viscous liquid. When a heavy powder, *e.g.* bismuth subnitrate, is suspended in such a liquid, the result is called a suspension.

Mucilago Acaciæ and M. Tragacanthæ are frequently used to form emulsions. Mucilago Acaciæ should be recently prepared. It is incompatible with iron perchloride, borax, and lead subacetate.

Lotio Hydrargyri Nigra is an example in B. P. of suspension.

Emulsions are coagulated by acids, an undue proportion of metallic salts, and alcoholic liquids.

PHARMACEUTICAL PROCESSES.

Many of these, as filtration, precipitation, &c., need no explanation, but the following require a few words.

Levigation consists in reducing a drug to a very fine powder by triturating it with a little water and drying the resulting paste.

Elutriation consists in diffusing an insoluble powder in water, letting the heavier part settle, then decanting the supernatant fluid. The heavier powder in this is allowed to settle, the fluid decanted, and so on until a fluid containing powder of the required fineness is obtained.

Lixiviation consists in the extraction with water of the soluble matter of the ashes of anything which has been ignited, the solution being called a "lye."

Maceration consists in leaving coarsely powdered solid organic substances in contact for some time, at the temperature of the atmosphere, with a liquid in a vessel which is frequently agitated. The resulting solution is poured off and added to the liquid obtained from the remaining substance by pressure. The whole may be concentrated by heat. Many extracts and tinctures are made by maceration.

Percolation is a process for obtaining the soluble constituents of a drug by the descent of a solvent through it. The drug to be percolated is packed in a tall vertical cylinder, tied over at its lower end with muslin. The percolating fluid, or menstruum, is poured in at the top of the cylinder, and as it drops out through the muslin it is collected. The **Marc** is the material after its exhaustion by maceration or percolation. Many liquid extracts, and tinctures of vegetable drugs are prepared by percolation.

Repercolation consists in using the liquid obtained by percolating a substance as the menstruum for percolating a second portion of the same substance and using the liquid from this second percolation as

a monstruum for percolating a third portion of the same substance, and so on as often as may be desired. The liquid extract of Belladonna is an example of repercolation.

Scaling.—Scale preparations are made by drying concentrated solutions of drugs on glass plates. The solid left behind forms a thin film on the plate, and this film is broken up. Some preparations of iron are scale preparations.

Standardizing.—The Pharmacopœia directs that certain preparations made from vegetable drugs shall be standardized—that is to say, shall be made to contain a certain fixed proportion of the chief active principle. The standardized preparations are (N.B.—1 per cent. expressed concretely in the metric system is 1 gramme in 100 millilitres; in the British system, 1 grain in 110 minims)—

Opium to make Tincture or Extract must contain not less than 7·5 per cent of Morphine. Otherwise not less than 9·5 and not more than 10·5 per cent.

Extractum Opii Siccum containing 20 per cent. of Morphine.

Extractum Opii Liquidum containing 0·75 per cent. of Morphine.

Tinctura Opii containing 1 per cent. of Morphine.

Tinctura Camphoræ Composita containing 0·05 per cent. of Morphine.

Tinctura Opii Ammoniata containing 0·1 per cent. of Morphine.

Nux Vomica powdered must contain 1·25 per cent. of Strychnine

Extractum Nucis Vomicæ Siccum containing 5 per cent. of Strychnine.

Extractum Nucis Vomicæ Liquidum containing 1·5 per cent. of Strychnine.

Tinctura Nucis Vomicæ containing 0·125 per cent. of Strychnine.

Belladonna Leaves must yield not less than 0·3 per cent. of alkaloids.

Tinctura Belladonnæ containing 0·035 per cent. of total alkaloids of the leaves.

Extractum Belladonnæ Siccum containing 1 per cent. of total alkaloids of the leaves.

EXTRACTUM BELLADONNÆ LIQUIDUM containing 0·75 per cent. of total alkaloids of the root.

EMPLASTRUM BELLADONNÆ containing 0·25 per cent. of total alkaloids of the root.

LINIMENTUM BELLADONNÆ containing 0·375 per cent. of total alkaloids of the root.

UNGUENTUM BELLADONNÆ containing 0·6 per cent. of total alkaloids of the root.

EXTRACTUM HYOSCYAMI containing 0·3 per cent. of the alkaloids of Hyoscyamus leaves.

EXTRACTUM CINCHONÆ LIQUIDUM containing 5 per cent. of total alkaloids.

TINCTURA CINCHONÆ containing 1 per cent. of total alkaloids.

TINCTURA CINCHONÆ COMPOSITA containing 0·5 per cent. of total alkaloids.

TINCTURA ACONITI containing 0·04 per cent. of the ether soluble alkaloids of Aconite root.

LINIMENTUM ACONITI containing 0·2 per cent. of the ether-soluble alkaloids of Aconite root.

EXTRACTUM IPECACUANHÆ LIQUIDUM containing 2·0 per cent. of total alkaloids.

VINUM IPECACUANHÆ containing 0·1 per cent. of total alkaloids.

AQUA LAUROCERASI containing 0·1 per cent. of Hydrocyanic Acid.

TINCTURA JALAPÆ containing 1·5 per cent. of jalap resin.

EXTRACTUM HYDRASTIS LIQUIDUM containing 2 per cent. of Hydrastine.

EMPLASTRUM CALEFACIENS containing 0·02 per cent. of Cantharidin.

EMPLASTRUM CANTHARIDINI containing 0·2 per cent. of Cantharidin.

EXTRACTUM FILICIS LIQUIDUM must contain not less than 20 per cent. of Filicin.

Physiological Standardization (Synonym: *Biological Assay*).—When a drug is a definite chemical body, *e.g.* arsenious acid, or its active principle is, *e.g.* strychnine in nux vomica, preparations of it can be standardized by chemical means; but, when its activity is due to a body or bodies which the chemist cannot estimate quantitatively, the attempt is made to estimate the strength of its preparations by observing the minimum fatal dose of each, when administered under similar conditions, to animals of the same species and weight. Such investigations have been made principally with digitalis, and it has been found that the amount of active principle in different specimens of the

tincture is variable. Or the drug may be standardized by observation of the degree of some striking physiological effect, *e.g.* preparations containing adrenalin (the active principle of suprarenal medulla) may be standardized by their effect on blood pressure.

WEIGHTS. MEASURES. SYMBOLS.

Imperial System.

WEIGHTS (Avoirdupois Weight).

1 grain . . .		Symbol, gr.
437·5 grains	= one OUNCE	,, oz.
16 ounces (7000 gr.)	= one POUND	,, lb

The Scruple (20 grains, symbol ℈) is rarely used, and the Drachm (60 grains, symbol ʒ) is sometimes used, but neither is official. What is known as Apothecaries' Weight, in which the ounce = 480 grains, is not official, but is sometimes used in America.

MEASURES OF CAPACITY.

1 minim		Symbol, min.
60 minims . . .	= one FLUID DRACHM	,, fl. dr.
8 fluid drachms (480 minims)	= one FLUID OUNCE	,, fl. oz.
20 fluid ounces . .	= one PINT	,, O
8 pints	= one GALLON	,, C

The following symbols are often used but they are not official: ♏ for minim; ʒ for fl. dr.; ℥ for fl. oz. The last two are even sometimes used ʒ to represent 60 gr. and ℥ to represent oz., but this is much to be deprecated.

Occasionally ʒ and ℥ are written f ʒ and f ℥ when they stand for fluid drachms and fluid ounces.

Relations of Measures to Weights.

1 minim	is the measure at 16·7° C. (62° F.) of	0·911	grain of water.
1 fluid drachm	,, ,,	54·687	,, ,,
1 fluid ounce	,, ,,	437·5 (the avoirdupois ounce)	,, ,,
1 pint	,, ,,	8750·0	grains of water.
1 gallon	,, ,,	70000·0	,, ,,

A 1 **per cent. solution** is approximately **a grain in 110 minims**, for 110♏ (strictly 109·7143) of water at 16·7° C. weighs 100 gr.

In the pharmacopœial description of the various proportions which several parts of a compound bear to one another, the word parts means parts by weight; the term fluid parts signifies the volume of an equal number of parts of water.

Metric System.—This, which is as follows, is official on the Continent and in the B. P. for the making of drugs and preparations, and, together with the Imperial, for doses.

WEIGHTS.

1 milligramme (Mg.)	=	0·001 gramme.
1 centigramme (Cg.)	=	0·01 ,,
1 decigramme (Dg.)	=	0·1 ,,
1 gramme (G.)	=	weight of 1 Millilitre or Mil which is 1 cubic centimetre of distilled water at 4° C. Abbreviation, often used, grm.
1 dekagramme	=	10·0 grammes.
1 hectogramme	=	100·0 ,,
1 kilogramme	=	1000·0 ,, Abbreviation, kilo.

MEASURES OF CAPACITY.

1 centimil (Cl.)	=	the vol. at 4° C. of	1 centigramme	of water.	
1 decimil (Dl.)	=	,, ,,	1 decigramme	,,	
1 millilitre or mil (Ml.)	=	,, ,,	1 gramme	,,	
1 centilitre	=	,, ,,	10 ,,	,,	
1 decilitre	=	,, ,,	100 ,,	,,	
1 litre	=	,, ,,	1000 ,,	(1 kilo.) ,,	

N.B.—1 cubic centimetre (abbrev. c.c.) is the same thing as one millilitre.

Conversion of British to Metric.

WEIGHTS.

1 grain	=	0·0648 G.
1 ounce	=	28·3495 ,,
1 pound	=	453·5924 ,, (rather under ½ a kilo.).

MEASURES.

1 minim	=	0·059 mil.
1 fluid drachm	=	3·55 ,,
1 fluid ounce	=	28·412 ,,
1 pint	=	568·245 ,, (rather over ½ a litre).
1 gallon	=	4·5 litres.

Conversion of Metric to British.

WEIGHTS.

1 milligramme	=	0·015432 grain.
1 centigramme	=	0·154 grain.
1 decigramme	=	1·543 grain.
1 gramme	=	15·432 grains.
1 kilogramme	=	15432·356 ,, = 2 lb. 3 oz. 119·8 grs.

MEASURES.

1 centimil = 0·169 minims
1 decimil = 1·69 „
1 millilitre, mil, or cubic centimetre = 16·95 „
1 litre (1000 c.c.) = 35·196 fluid ounces, or 1·76 pint.

In prescribing on the Continent all liquids are weighed, the weight of liquids and solids is expressed in grammes, and this word is omitted. Thus—

Mag. Sulph. 20·0 = 20 grammes of Magnesium Sulphate.
Hydrarg. Subchlor. 0·5 = half a gramme of Mercurous Chloride.
Tinctura Rhei 1·5 = a gramme and a half of Tinctura Rhei.

The following approximately accurate table will be useful:

17 ♏ = 1 cubic centimetre.
1 fluid drachm = 3·5 grammes (G.), mils, or cubic centimetres (c.c.).
1 ounce = 28·4 „ „ „ „ „

Approximate Equivalences Imperial and Metric.

WEIGHTS.

Imperial Grains.	Metric Milligrammes.
$\frac{1}{200}$	0·3
$\frac{1}{100}$	0·6
$\frac{1}{65}$	1·0
$\frac{1}{40}$	1·5
$\frac{1}{32}$	2·0
$\frac{1}{25}$	2·5
$\frac{1}{20}$	3·0
$\frac{1}{16}$	4·0
$\frac{1}{10}$	6·0
$\frac{1}{8}$	8·0
$\frac{1}{5}$	12·0
$\frac{1}{4}$	16·0
$\frac{1}{2}$	30·0

Imperial Grains.	Metric Decigrammes.
3	2
5	3
8	5
10	6
15	10
20	12
30	20
60	40

Grains.	Centigrammes.
1	6
2	12
3	20
4	25
5	30
8	50
10	60

Grains.	Grammes.
15	1
30	2
45	3
60	4
120	8
150	10
180	12
240	16
480	32

VOLUMES.

Minims.	Centimils.	Minims.	Mils.
½	3	15	1
1	6	30	2
2	12	45	3
3	18	60	4
5	30	90	6
8	50	Fluid drachms.	Mils.
		½	2
		1	4
Minims.	Decimils.	2	8
5	3	6	24
10	6	Fluid ounces.	Mils.
15	10	½	15
20	12	1	30
30	18	2	60
60	36	4	120

Domestic Measures.

A TEA-SPOONFUL is rather over a fluid drachm. Usually it is 5 mils, nearly.

A DESSERT-SPOONFUL is about two fluid drachms.

A TABLE-SPOONFUL is about half a fluid ounce. Usually it is very nearly 15 mils.

A WINE-GLASSFUL is about one and a half to two fluid ounces.

A TEA-CUPFUL is about five fluid ounces.

A BREAKFAST-CUPFUL is about eight fluid ounces.

A TUMBLERFUL is about eleven fluid ounces.

A DROP is often taken as being about a minim, but drops vary so much in size that they should never be used for children nor as a measure of powerful drugs. For example, the number of drops in a fluid drachm of the United States syrup of acacia is 44, of water 60, of alcohol 146, of chloroform 250.

PHARMACOPŒIAL PREPARATIONS AND THEIR DOSES.

Most drugs are not, in their natural state, fit for administration. They are either too bulky, too nauseous, or contain noxious principles. Preparations suitable for administration are therefore prepared from them according to "official" pharmacopœial directions. The Pharmacopœia states the doses

of the various drugs and their preparations which may safely be given to an adult, but these doses are often not rigorously kept in prescribing. They vary with the purpose for which the drug is required and the age of the patient (*see* Prescribing). The following is an account of the preparation of the pharmacopœial preparations, and in the attempt to group the doses so as to make them easy to remember, the official doses have been as closely adhered to as possible.

Aceta.—Solutions of the active principles of the drug extracted from it by maceration or digestion with acetic acid (not vinegar). The B. P. contains three.

	Dose.		*Dose.*
Acetum Cantharidini	Ext. use only.	Acetum Scillæ — Urgineæ	5–15 ♏. 3 to 10 decimils

For Acetum Cantharidini both glacial and ordinary acetic acid are used.

Aquæ. — Aqueous solutions impregnated with some volatile substance.

Those in the B. P. directed to be made by distilling the drug with water are—

	Dose.		*Dose.*
Aqua Anethi — Anisi — Aurantii Floris — Carui — Cinnamomi	1–2 fl. oz. 30 to 60 mils	Aqua Fœniculi — Rosæ	1–2 fl. oz. 30 to 60 mils

Aqua Laurocerasi (Standardized 0·1 per cent. of Hydrocyanic Acid) ½–2 fl. dr.—2 to 8 mils (note dose).

Aqua Aurantii Floris and Aqua Rosæ are prepared by dilution of commercial orange flower water and commercial rose water, which are made by distillation.

Two are directed to be made by distilling the essential oil with water:

	Dose.		*Dose.*
Aqua Menthæ Piperitæ	1–2 fl. oz. 30 to 60 mils	Aqua Menthæ Viridis	1–2 fl. oz. 30 to 60 mils

In actual practice all Aquæ directed to be made from substances containing volatile oils are very often prepared by adding to water the volatile oil with some

calcium phosphate or other insoluble powder to diffuse it through the water, which is filtered off and forms the Aqua. The Pharmacopœia allows this method to be used in hot climates.

Two are simple solutions in cold water:

	Dose.		Dose.
Aqua Camphoræ (The solution is aided with alcohol)	1–2 fl. oz. 30 to 60 mils	Aqua Chloroformi (1 in 400)	1–2 fl. oz. 30 to 60 mils

Collodia (collodions).—Solutions of pyroxylin. When applied externally a protective film is formed owing to the rapid volatilization of the solvent. The B. P. contains three:

Collodium	Collodium Vesicans
— Flexile	

Confectiones (Syn. electuaries, boluses, conserves).—Powders made into a paste with sugar or honey, of such a consistency that the powder does not separate, but the mass can be swallowed. The B. P. contains four:

	Dose.		Dose.
Confectio Rosæ Gallicæ	Used as a basis for pills.	Confectio Piperis — Sennæ — Sulphuris	60 to 120 grains, 4 to 8 grms.

Decocta.—Solutions of the non-volatile active principles of vegetable drugs, made by boiling the ingredients in distilled water, in a covered vessel, for from 5 to 10 minutes, and straining. The B. P. contains seven. The dose of each is $\frac{1}{2}$ to 2 fl. oz., 15 to 60 mils. They are—

Decoctum Acaciæ Corticis	Decoctum Hæmatoxyli
——— Agropyri	——— Ispaghulæ
——— Aloes Co.	——— Sappan
——— Gossypii Radicis Corticis	

Decoctions should be fresh made, as they readily decompose.

Emplastra.—Plasters consist of tenacious, pliable, solid substances heated enough to be spread with a heated spatula, generally upon the rough side of sheepskin leather, but sometimes on wash leather, brown holland, silk, or the smooth side of swansdown. They are only used for application to the skin, to which they adhere at the temperature of the body. The following list from the B. P. shows that ALL BUT TWO ARE DERIVED FROM E. PLUMBI:

Emplastrum Plumbi	Oxide of lead, olive oil, and water. OLEATE OF LEAD AND GLYCERIN ARE FORMED.
— Hydrargyri — Resinæ — Saponis	Lead plaster is the basis.
— Belladonnæ — Calefaciens	Resin plaster, which is made from lead plaster is the basis.
— Cantharidini	Wool fat and beeswax form the basis.
— Menthol	Resin is the chief basis.

In tropical and subtropical parts of the Empire more or less hard soap, resin, or yellow beeswax may be used to make plasters when prevailing high temperatures otherwise render the basis too soft, but the official proportion of the active ingredient must be maintained.

A plaster is usually prescribed to be of a definite size and shape, but occasionally—*e.g.* in the case of one to put on the breast or behind the ear—the size and shape are left to the dispenser. If it is thought that a plaster will not stick to the skin it may be provided with a margin of adhesive plaster (Emplastrum Resinæ).

Extracta.—Concentrated preparations made by evaporating either the expressed juice of plants, or a solution of the soluble constituents of dried drugs. If the solid extract would otherwise be too poisonous, it may be diluted with sugar of milk, as in Ex. Strophanthi. Some, *e.g.* Ex. Euonymi,

contain Calcium Phosphate to keep the extract in the form of a powder. Extracts are of different kinds.

(1) **Fresh Extracts.**—Heat the juice expressed from the bruised plant to 100° C. to coagulate the protein, filter, evaporate the filtrate. The B. P. contains Ex Colchici and Taraxaci.

(2) **Aqueous Extracts.**—Treat dry drugs with cold, hot, or boiling water, and evaporate to a proper consistency. Examples: Ex. Opii Siccum, &c. In three cases (Ex. Belæ Liquidum; Ex. Glycyrrhizæ; Ex. Glycyrrhizæ Liquidum) the extractive is chloroform water, which is used as it is a preservative. These extracts are really aqueous.

(3) **Alcoholic Extracts.**—Treat dry drugs with alcohol with or without the addition of water, and evaporate to a proper consistency. Examples: Ex. Cannabis Indicæ, &c. In some cases the solid extract is made by evaporation of the official liquid extract, *e.g.* Ex. Nucis Vomicæ Siccum.

(4) **Ethereal Extracts.**—The dry drug is percolated with ether (Ex. Filicis Liquidum). In the case of Ex. Strophanthi, which is really an alcoholic extract, the fatty matter is removed by extraction with ether, the mass is then extracted with alcohol.

(5) **Liquid Extracts.**—These are aqueous, or alcoholic, or aqueous and alcoholic extracts evaporated to form concentrated liquid solutions of syrupy consistence. They are made by the maceration or percolation processes (p. 7). Occasionally, as in Ext. Belladonnæ Liquidum, the percolate is again used to percolate the menstruum two, three, or more times until the required strength is attained. If aqueous, some alcohol may be added to prevent decomposition, or to precipitate any albuminous matter, which is then removed by filtration. Examples: Ex. Ergotæ Liquidum, Hydrastis Liquidum, &c.

Any liquid extract containing less than one-fourth its weight of alcohol (90 per cent.) may have the alcohol increased to an amount not exceeding one-fourth the weight of the extract in tropical or subtropical climates if otherwise the preparation would be liable to ferment.

Solid Extracts.	Dose.
Extractum Belladonnæ Siccum — Cannabis Indicæ — Colchici — Nucis Vomicæ Siccum — Opii Siccum — Strophanthi	¼–1 gr. 16 to 60 milligrms.
— Euonymi	1–2 gr. 6 to 12 centigrms.
— Aloes	1–4 gr. 6 to 25 centigrms.
— Cascaræ Sagradæ Siccum — Colocynthidis Co. — Ergotæ — Gentianæ — Hyoscyam — Rhei	2–8 gr. 12 to 50 centigrms.
— Glycyrrhizæ — Krameriæ — Taraxaci	5–15 gr. 3 to 10 decigrms.

Liquid Extracts.	Dose.
Extractum Ipecacuanhæ	½–2 ♏ 3 to 12 centimils
— Nucis Vomicæ	1–3 ♏ 6 to 18 centimils
— Cinchonæ — Hamamelidis — Hydrastis	5–15 ♏ 3 to 10 decimils
— Ergotæ — Grindeliæ — Opii	5–30 ♏ 3 to 18 decimils
— Picrorhizæ	15–60 ♏ 1 to 4 mils
— Cascara Sagradæ — Glycyrrhizæ — Gossypii Radicis Corticis — Kavæ	½–1 fl. dr. 2 to 4 mils
— Filicis	45–90♏ 3 to 6 mils
— Agropyri — Belæ — Viburni	1–2 fl. dr. 4 to 8 mils
— Belladonnæ Liq. is only used to make other preparations.	

The dried extracts of Belladonna, Nux Vomica, and *Opium*, the extract of Hyoscyamus, and the liquid extracts of Belladonna, Nux Vomica, Cinchona, Hydrastis, Ipecacuanha, and Opium are standardized (*see* p. 8).

Glycerina.—Solutions of drugs in glycerin. They are liquid preparations, except Glycerinum Tragacanthæ and Glycerinum Amyli, which are semi-solid. All are for external application except Glycerinum Tragacanthæ (used to make pills) and Glycerinum Pepsini. The B. P. contains—

Glycerinum Acidi Borici
— Acidi Carbolici
— Acidi Tannici
— Aluminis
— Amyli

Glycerinum Boracis
— Pepsini
— Plumbi Subacetatis
— Tragacanthæ

Infusa.—Solutions made by pouring boiling distilled water upon the drug to be extracted, then covering up the vessel, agitating from time to time, usually for a quarter of an hour, sometimes for half an hour, sometimes for one hour, and straining. The filtrate is the infusion.

Inf. **Calumbæ** and Inf. **Quassiæ** are made with **Cold Water**, to prevent the solution of the starch calumba contains and the solution of too much of the bitter principle quassia contains.

Two are compound, viz. Inf. Aurantii Co., Inf. Gentianæ Co.

Two contain acid: Inf. Cinchonæ Acidum, Inf. Rosæ Acidum.

The dose of all is ½–1 fl. oz., 15 to 30 mils, except Inf. Buchu, Ergotæ, Scoparii, all 1–2 fl. oz., 30 to 60 mils, and **Inf. Digitalis 2–4 fluid drachms**, 8 to 16 mils.

Infusions should be made fresh, as they all, except Inf. Caryophylli and Inf. Rosæ Acidum, readily decompose.

Injectiones.—Concentrated solutions for injection under the skin. The B. P. contains five—

			Strength.
Injectio	Apomorphinæ	Hypodermica	(1 per cent.)
„	Cocainæ	„	(5 per cent.)
„	Ergotæ	„	(33 per cent. of the Extract of Ergot)
„	Morphinæ	„	(2·5 per cent. of Morphine Tartrate)
„	Strychninæ	„	(0·75 per cent. of Strychnine Hydrochloride)

Lamellæ.—Small thin discs made with gelatin and glycerin, and used to drop into the eye. The B. P. contains four—

Lamella Atropinæ (each contains $\frac{1}{5000}$ gr. (0·013 milligrm.) atropine sulphate).

Lamella Cocainæ (each contains $\frac{1}{50}$ gr. (1·3 milligrms.) cocaine hydrochloride).

Lamella Homatropinæ (each contains $\frac{1}{100}$ gr. (0·65 milligrm.) of homatropine hydrobromide).

Lamella Physostigminæ (each contains $\frac{1}{1000}$ gr. (0·065 milligrm.) physostigmine sulphate).

Linimenta.—Liniments or embrocations are applications of an oily or spirituous consistence, all of which are intended to be rubbed into the skin except Lin. Aconiti, which is painted on it; and Lin. Calcis, which is simply applied to it. Most contain camphor, many contain olive oil, some contain alcohol or glycerin.

Liquores.—Solutions generally of definite chemical bodies, and in which the solvent is usually distilled water. In many cases these are the only constituents. The few exceptions can be found by reference to individual Liquors.

The following strengths should be remembered:

	Strength.		*Strength.*
Liquor Arsenicalis	1 p. c., 1 grm. in 100 millilitres, or 1 gr. in 110♏ or about $4\frac{1}{3}$ gr. in 1 fl. oz.	Liquor Morphinæ Hydrochloridi	1 p. c., 1 grm. in 100 millilitres, or 1 gr. in 110♏, or about $4\frac{1}{3}$ gr. in 1 fl. oz.
— Arsenici Hydrochloricus		— — Tartratis	
— Arsenii et Hydrargyri Iodidi		— Potassii Permanganatis	
— Atropinæ Sulphatis		— Sodii Arsenatis	
— Morphinæ Acetatis		— Strychninæ Hydrochloridi	
		— Trinitrini	

— Hydrargyri Perchloridi 0·1 per cent., 0·1 grm. in 100 millilitres, $\frac{1}{10}$ gr. in 110♏.

The following are the doses of Liquors:

	Approximate Dose.
Liquor Trinitrini — Atropinæ Sulphatis	½–2 m 3 to 12 centimils
— Arsenicalis — Arsenici Hydrochloricus — Sodii Arsenatis — Strychninæ Hydrochloridi	2–8 m 12 to 50 centimils
— Ferri Perchloridi	5–15 m 3 to 10 decimils
— Adrenalini Hydrochloricus — Ammoniæ — Arsenici et Hydrargyri Iodidi — Potassæ — Sodæ Chlorinatæ	10–30 m 6 to 18 decimils

	Approximate Dose.
Liquor Bismuthi et Ammonii Citratis — Calcis Saccharatus — Ethyl Nitritis — Hydrargyri Perchloridi — Morphinæ Acetatis — — Hydrochloridi — — Tartratis	15–60 m 1 to 4 mils.
— Hydrogenii Peroxidi — Pancreatis	½–2 fl.dr. 2 to 8 mils.
— Ammonii Acetatis — — Citratis — Potassii Permanganatis	2–6 fl.dr. 8 to 24 mils.
— Calcis — Magnesii Bicarbonatis	1–4 fl.oz. 30 to 120 mils.

Not used internally:

Liquor Acidi Chromici.
— Ammoniæ Fortis.
— Calcis Chlorinatæ.
— Cresol Saponatus.
— Epispasticus.
— Ferri Perchloridi Fortis.
— — Persulphatis.
— Formaldehydi.

Liquor Formaldehydi Saponatus.
— Hamamelidis.
— Hydrargyri Nitratis Acidus.
— Picis Carbonis.
— Plumbi Subacetatis Fortis.
— — — Dilutus.
— Zinci Chloridi.

Lotiones.—Aqueous mixtures for external use, generally applied on lint, or washed on the part. The B. P. contains two:

Lotio Hydrargyri Flava and Lotio Hydrargyri Nigra.

Mella.—Mixtures of some substance with purified honey. The B. P. contains only one:

Mel Boracis.

Misturæ.—Liquid preparations consisting of one or more drugs dissolved in water or diffused in a solution of gum or some other thick fluid. The mixture is usually flavoured, and is for internal administration.

Example in B. P. of solutions: M. Sennæ Composita.

Examples in B. P. of suspension: M. Ammoniaci (the gum of which suspends the resin), M. Cretæ, M. Guaiaci (suspended in tragacanth), M. Olei Ricini (emulsified in gum).

The usual dose of all is ½–1 fl. oz.—15 to 30 mils.

Mucilagines.—Mucilages are aqueous, viscid solutions or partial solutions of gum used for suspending insoluble substances. The B. P. contains three:

Mucilago Acaciæ, Mucilago Gummi Indici, and Mucilago Tragacanthæ.

There is no fixed dose; it is usually about 1 fl. dr.

Olea.—There are many oils in the Pharmacopœia. They are all obtained by distillation or by expression except Oleum Phosphoratum, which is a solution of phosphorus in almond oil. The B. P. olea are—

	Dose.
Oleum Crotonis	½–1♏ 3 to 6 centimils
— Ajowan	½–3♏ 3 to 18 centimils
— Anethi	
— Anisi	
— Anthemidis	
— Cajuputi	
— Carui	
— Caryophylli	
— Cinnamomi	
— Coriandri	
— Eucalypti	
— Graminis Citrati	
— Juniperi	
— Lavandulæ	
Oleum Limonis	½–3♏ 3 to 18 centimils
— Menthæ Piperitæ	
— Menthæ Viridis	
— Myristicæ	
— Rosmarini	
— Phosphoratum	1–5♏ 6 to 30 centimils
— Chaulmoogræ	5–20♏ 3 to 12 decimils
— Copaibæ	
— Cubebæ	
— Gaultheriæ	
— Santali	
— Terebinthinæ Rect.	2–10♏ 12 to 60 centimils
— „ „	3–4 fl.dr. 12 to 15 mils

	Dose.		Dose.
Oleum Morrhuæ — Ricini	1—6 fl.dr. 4 to 24 mils.	Oleum Olivæ — Abietis — Rosæ — Rosmarini — Sesami — Sinapis Volatile — Theobromatis	Not often given internally.
— Amygdalæ — Arachis — Cadinum — Lini	Not often given internally.		

Oxymella.—Oxymels are preparations containing honey and acetic acid. Besides oxymel the B. P. contains only two:

Oxymel Scillæ and Oxymel Urgineæ. *Dose* $\frac{1}{2}$–1 fl. dr.—2 to 4 mils.

Pilulæ.—Solid spherical bodies containing medicinal agents, and intended to be swallowed whole. A mass of the consistence of firm clay is made by beating medicaments together in a mortar. This mass is with a machine divided up and rolled into pills. In order that they may not possess a disagreeable taste, they are often varnished or sugar-coated. Unless the constituents are very heavy, each pill should not exceed 5 grains in weight, and the smaller they are the better. Syrup of glucose, glycerin of tragacanth, and glucanth (tragacanth, 1; glycerin, 3; water, 1; syrup of glucose, 7) are three of the most generally useful excipients. Curd soap is useful for creosote (*q.v.*), and for essential oils if a little calcium phosphate and wheaten flour be added. Confection of roses was formerly very commonly employed. Liquorice powder is a good absorbent. Glycerin is so much used because it attracts moisture and prevents the pill from getting hard, but pills made with much of it soon become very soft: this may be hindered by alcohol. All pills are useless unless so made that they will dissolve in the gastro-intestinal canal. If it is required that they should not be acted upon until they reach the intestine, they should be

coated with keratin. Pills may be kept in some powder, as lycopodium, to prevent their sticking together. All purgative pills contain aloes. All pharmacopœial pills are given in doses of about 4 to 8 grains (25 to 50 centigrms.), except—

Pilula Phosphori. *Dose* 1–4 gr.—6 to 25 centigrms.
— Plumbi cum Opio.
— Saponis Composita. } *Dose* 2–4 gr.—12 to 25 centigrms.
— Ferri. *Dose* 5–15 gr.—3 to 10 decigrms.

Pulveres.—Powders are mixtures of finely powdered drugs. The best diluent for powders is sugar of milk, because of its hardness and comparative insolubility. The B. P. contains:

	Dose.		*Dose.*
Pulvis Antimonialis	3–6 gr. 2 to 4 decigrms	Pulvis Cretæ Aromaticus — — — cum Opio — Jalapæ Co. — Kaladanæ Co. — Rhei Co. — Tragacanthæ Co.	10–60 gr. 6 to 40 decigrms
— Ipecacuanhæ Co. — Opii Co.	5–15 gr. 3 to 10 decigrms.		
— Buteæ Seminum — Kino Co. — Scammonii Co.	5–20 gr. 3 to 12 decigrms		
— Catechu Co. — Cinnamomi Co.	10–60 gr. 6 to 40 decigrms.	— Glycyrrhizæ Co.	60–120 gr. 4 to 8 grms.

Pulvis Sodæ Tartaratæ Effervescens (Seidlitz Powder). (*See* Sodium Compounds.) There is no special dose for Pulvis Amygdalæ Co.

Spiritus.—Spirits are either simple or complex. Simple Spirits are solutions (which frequently become turbid on the addition of water, owing to the separation of the substance dissolved) in alcohol (90 per cent.) of—

(*a*) A volatile oil:

Spiritus Anisi
— Cajuputi
— Cinnamomi
— Juniperi
Spiritus Lavandulæ
— Menthæ Piperitæ
— Myristicæ
— Rosmarini

The strength of all these is 1 in 10, and the dose 5–20♏—3 to 12 decimils.

(*b*) Of camphor:
Spiritus Camphoræ. *Strength* 1 in 10. *Dose* 5–20♏—3 to 12 decimils.

(*c*) Of chloroform:
Spiritus Chloroformi. *Strength* 1 in 20. *Dose* 5–40♏—3 to 25 decimils.

(*d*) Of ether:
Spiritus Ætheris *Strength* 1 in 3. *Dose* 20–90♏.—12 decimils to 6 mils.

Complex Spirits are of varying composition. They are all prepared by distillation. The B. P. contains four, viz.:

	Dose.		*Dose.*
Spiritus Nitrosi — Ammoniæ Aromaticus	20–90♏ 12 decimils to 6 mils.	Spiritus Ammoniæ Fetidus — Armoraciæ Co.	20–90♏ 12 decimils to 6 mils.

Spiritus Rectificatus is also pharmacopœial.

NOTE.—Sp. is in English a common abbreviation for Spiritus. In French it is the abbreviation for Syrup.

Succi.—These are the expressed juices of plants, to which a third of their volume of alcohol (90 per cent.) is added to preserve them. The B. P. contains three:

	Dose.
Succus Scoparii — Taraxaci	1–2 fl. dr.—4 to 8 mils.

Succus Limonis contains no alcohol.

Suppositoria.—Suppositories are conical solid bodies containing active drugs for introduction into the rectum or vagina. Each is made to weigh 1 grm. The basis of all is oil of theobroma, except Sup. Glycerini in which it is gelatin.

The B. P. contains seven, viz. Sup. Acidi Carbolici, Acidi Tannici, Belladonnæ, Glycerini, Morphinæ, Iodoformi, and Plumbi Co.

In hot countries if the Suppositories would otherwise be too soft, some of the Oil of Theobroma may be replaced by White Beeswax.

Syrupi.—Syrups are fluid preparations of drugs flavoured with sugar.

Examples: Sy. Aurantii, Sy. Rhei. The dose of all is ½ to 1 fl. dr. (2 to 4 mils), except Sy. Cascaræ Aromaticus, Sy. Chloral., Sy. Codeinæ Phosphatis, Sy. Rhei, and Sy. Sennæ, of which it is ½ to 2 fl. dr. (2 to 8 mils).

Tabellæ.—Tablets of chocolate, each weighing five grains. The B. P. contains only one:

Tabella Trinitrini (each contains $\frac{1}{130}$ gr. or 0·5 milligramme pure nitro-glycerin). *Dose* 1–2.

Tincturæ.—Tinctures are solutions of the active principles of drugs in alcohol. They are closely allied to spirits, from which most of them differ in their mode of preparation. They are prepared by—

(*a*) Maceration. The drug is placed in a closed vessel with the whole of the menstruum for seven days, and occasionally shaken. It is then strained. The marc is pressed, and the strained and pressed liquids mixed; *e.g.* Tinct. Opii.

(*b*) Percolation. Moisten the drug with the prescribed quantity of menstruum for four hours, pack in the percolator, add enough menstruum to saturate and leave a layer of liquid above. Macerate for twenty-four hours. Let percolation proceed slowly until the percolate measures three-fourths of the finished tincture. The marc is pressed, and the fluid extracted is added to that percolated. After filtration enough menstruum is added to make the prescribed volume of tincture; clarify by subsidence or filtration if necessary; *e.g.* Tinct. Buchu. For the process of repercolation see p. 7.

(*c*) Simple mixing or solution of ingredients; *e.g.* Tinct. Chloroformi et Morphinæ Composita, Tinct. Ferri Perchloridi, Tinct. Quininæ.

Tinctures containing only one active substance are simple. The rest are compound; *e.g.* Tinct. Camphoræ Co.

Some are compound although it is not expressed in their name: they are Tincturæ Catechu, Valerianæ Ammoniata, Valerianæ Indicæ Ammoniata, Guaiaci Ammoniata, and Opii Ammoniata.

It will be observed that, with the exception of four, all tinctures given internally have a dose of either 5–15♏ or ½ to 1 fl. dr. Tinct. Iodi Fortis and Tinct. Pyrethri are not used internally.

	Dose.
Tinctura Aconiti	2–5 ♏ 12 to 30 centimils
— Cantharidini	
— Iodi Mitis	
— Strophanthi	
— Belladonnæ	5–15 ♏ 3 to 10 decimils
— Cannabis Indicæ	
— Capsici	
— Chloroformi et Morphinæ Co.	
— Cocci	
— Colchici	
— Daturæ Seminum	
— Digitalis	
— Ferri Perchloridi	
— Gelsemii	
— Lobeliæ Ætherea	
— Nucis Vomicæ	
— Opii	
— Podophylli	
— —— Indici	
— Scillæ	
— Stramonii	
— Urgineæ	
— Alstoniæ	½–1 fl. dr. 2 to 4 mils.
— Arnicæ Florum	
— Asafetidæ	
— Aurantii	
— Benzoini Co.	
— Berberidis	
— Buchu	
— Calumbæ	
— Camphoræ Co.	
— Cardamomi Co.	
— Cascarillæ	
— Catechu	
— Chiratæ	

	Dose.
Tinctura Cinchonæ	½–1 fl. dr. 2 to 4 mils.
— — Co.	
— Cinnamomi	
— Cubebæ	
— Ergotæ Ammoniata	
— Gentianæ Co.	
— Guaiaci Ammoniata	
— Hamamelidis	
— Hydrastis	
— Hyoscyami	
— Jalapæ	
— Jalapæ Co.	
— Kaladanæ	
— Kino	
— Krameriæ	
— Lavandulæ Co.	
— Limonis	
— Myrrhæ	
— Oliveri Corticis	
— Opii Ammoniata	
— Picrorhizæ	
— Pruni Virginianæ	
— Quassiæ	
— Quillaiæ	
— Quininæ	
— — Ammoniata	
— Rhei Co.	
— Senegæ	
— Sennæ Co.	
— Serpentariæ	
— Tolutana	
— Valerianæ Ammoniata	
— — Indicæ Ammoniata	
— Zingiberis	

Several are standardized (*see* p. 8).

Trochisci.—Lozenges or Troches are solid preparations for taking by the mouth. They are made

either with a fruit basis, a rose basis, a simple basis, or a tolu basis.

Fruit basis.—Take 500 times the quantity of the drug ordered for one lozenge. Mix it with 20 grms. of refined sugar and 6·5 grms. of tragacanth. Make the mixture into a paste with sufficient of the black currant paste of commerce to produce 650 grms. Divide into 500 lozenges and dry in hot air chamber; *e.g.* Troch. Acidi Benzoici, Troch. Catechu.

Rose basis.—These lozenges are made in the same way, using the simple basis, except that they are flavoured with oil of rose instead of black currant; *e.g.* Troch. Potassii Chloratis.

Simple basis.—These lozenges are made in the same way except that neither rose water nor black currant is used; the basis is gum acacia; *e.g.* Troch. Ferri Redacti, Troch. Santonini.

Tolu basis.—These lozenges are made in the same way as the simple except that Tincture of Tolu is added; *e.g.* Troch. Morphinæ, Troch. Acidi Tannici.

Troch. Sulphuris has a special mode of preparation.

Unguenta.—Ointments are semi-solid preparations consisting of a fatty substance mixed with an active drug. They are spread over the skin, or may be rubbed into it. They are only intended for external use. The basis is either lard, olive oil, wax, spermaceti, paraffin, or hydrous wool fat. Benzoated lard is often used to prevent decomposition. When it is required that the active ingredient should be absorbed, lard, which melts at about the temperature of the body, or hydrous wool fat, is the best basis; when the ointment is required for sores paraffin is a good basis, as it only softens a little at the temperature of the body.

In hot countries if the ointment would otherwise be too soft, the basis may be replaced by benzoated lard, prepared suet, yellow beeswax or white beeswax.

Vina.—Wines are weak tinctures, the drug being extracted with sherry in all except Vinum Ferri Citratis and Vinum Quininæ, in which orange wine is used,

and Vinum Aurantii, which is merely a fermented saccharine solution to which orange peel is added.

The dose of Vin. Colchici is 10 to 30♏ (6 to 18 decimils), of Vin. Quininæ ½ to 1 fl. oz. (15 to 30 mils).

With V. Antimoniale and V. Ipecacuanhæ the dose depends upon the purpose for which the drug is used.

The dose of the others is 1 to 4 fl. dr. (4 to 16 mils).

V. Ipecacuanhæ is standardized (*see* p. 8).

The following NON-PHARMACOPŒIAL PREPARATIONS are used :

Abstracta.—Powdered extracts double the strength of the crude drug. They are official in the United States Pharmacopœia.

Bougies.—Solid cylinders impregnated with various drugs, and used for introduction into the ear (called aurinaria), nose (called buginaria), or urethra. They are made either of gelatin (to be dipped in warm water before use) or oil of theobroma (to be dipped in oil before use). Those for the urethra are made in six sizes, varying from $\frac{1}{8}$ to $\frac{5}{16}$ inch in diameter.

Cachets, made of wafer paper, consist of two watch-glass-shaped halves. The drug is enclosed between them, and they adhere when moistened. The cachet is slightly moistened, put in the back of the mouth, and quickly washed down with a little water. This is an excellent way of giving drugs which are either nauseous or difficult of solution or suspension. Cachets are commonly used for antipyrin ; bismuth salts ; compound ipecacuanha powder ; guaiacol carbonate ; phenacetin ; quinine salts ; aspirin, salol, and other salicylates ; sulphonal, trional, and veronal.

Capsules of gelatin are used in the same way as cachets. They are very useful for nauseous oils.

Cataplasmata.—Soft, pasty external applications made with boiling water having linseed meal as a basis and applied warm (*see* Linseed). An ice poultice consists of crushed ice.

Cerata are ointments containing wax. They are official in the United States Pharmacopœia.

Cigarettes.—The drug replaces the tobacco of an ordinary cigarette.

Collunaria.—Fluids used as nasal douches.

Collyria.—Fluids used as eye washes.

Cremora.—Creams are preparations having glycerin, vaseline, or some similar substance as a basis, and used for external application.

Elixirs are liquids. All contain alcohol and syrup. Most are made with orange peel. Some contain aromatic oils. They are official in the United States Pharmacopœia. Some are simply flavouring agents, others contain active ingredients. The British Pharmaceutical Conference has published several, *e.g.* Elixir Cascara Sagrada (same as Syrupus Cascara Sagrada B. P.), Elixir Glusidi, Elixir Guaranæ, Elixir Phosphori, Elixir Rhei, Elixir Sennæ, Elixir Simplex (same as Syrupus Aromaticus B. P.)

Emulsiones.—Mixtures in which the drug exists as an emulsion.

Enemata (enemas or clysters).—Liquid preparations intended for injection into the rectum. When their object is to empty the bowel they are large in bulk (10 to 20 fl. oz.); when it is wished that they should be retained they are usually smaller in bulk. After injection a towel may be pressed against the anus. Mucilage made with starch (*see* Starch) is a good basis.

Essentiæ (essences).—Solutions of volatile oils in rectified spirit, usually of a strength of 1 in 5.

Fomenta.—Fomentations consist of flannels wrung out in hot water, to which drugs may or may not have been added.

Gargarisma.—A fluid preparation used for gargling.

Granules are small pills.

Guttæ.—Fluid preparations to be dropped into the eye.

Haustus.—A draught. This term is used when only a single dose of a fluid preparation is required.

Insufflationes.—Powders for blowing into the throat and larynx.

Lanolinum.—An ointment with hydrous wool fat as a basis.

Linctus.—This has honey, treacle, or some other thick substance as a basis. It is to be swallowed slowly, being retained some time in the mouth.

Massæ consist of substances mixed so as to be of a consistency suitable for making pills. They are official in the United States Pharmacopœia.

Mollinum.—A mollinum is an ointment having for its basis mollin, a superfatted soap. It is readily absorbed, and also readily washed off with water.

Nebulæ.—Solutions sprayed into the throat by means of an atomizer.

Paste.—A preparation to be applied as an ointment.

Pastillus.—Pastils are lozenges having glyco-gelatin as a basis.

Perles are small gelatin capsules.

Pessus.—Pessaries are solid preparations made like suppositories, and introduced into the vagina.

Pigmentum.—A paint is a preparation adapted for painting on the skin, throat, &c.

Tablets.—Solid, disc-like or lenticular bodies made by compression. They are very popular, but are sometimes useless, for they may be so hard and insoluble that they are found in the fæces quite unaltered.

Triturationes are intimate mixtures of substances with sugar of milk. They are official in the United States Pharmacopœia.

Vapores.—Inhalations are preparations arranged for the inhalation of volatile drugs.

Vaselinum.—This term is applied to an ointment the basis of which is vaseline.

PHARMACOLOGY AND THERAPEUTICS.

Before describing the actions and uses of drugs we must consider the manner, quantity, and form in which to give them.

MODES OF ADMINISTRATION OF DRUGS.

(*a*) **Into the blood-vessels by injection.** This method is rarely used in man, except that a saline solution (rather more than a teaspoonful of common salt to the pint of sterilized water at the temperature of the body) is injected into a vein in cases of great collapse, and salvarsan for syphilis.

(*b*) **Into the subcutaneous tissues by hypodermic injection.** The skin of the patient, where it is lax, should be raised between the thumb and forefinger of the operator's left hand; the skin of the forearm is often selected. In his right hand he takes a perfectly clean syringe containing the quantity of fluid to be injected, and fitted with an aseptic hollow silver needle, which is thrust under the raised piece of skin, but not into the muscles, for about an inch, care being taken to avoid wounding a vein. The syringe is slowly emptied, then withdrawn, and the thumb pressed lightly upon the seat of injection for a few seconds. The advantage of this method is that the drug is surely and quickly absorbed. The fluid used must not contain solid particles, nor be irritating, or abscesses will result; it must be aseptic, and therefore if it is not freshly prepared it may contain a little carbolic acid—or, better still, boracic acid, for this is non-poisonous and non-irritating. The bulk injected should, if possible, be about five minims. For injec-

tions that are not in constant use it is advisable to keep the drugs in the form of lamellæ, and to dissolve one in a few minims of water as required. Mercurials are occasionally injected directly into muscles (*see* Mercury).

(c) **Into serous cavities** by injection. This method is rarely used in man except when the object is to wash out, with saline solution, a serous cavity, as the pleura, which has been opened, or to produce adhesive inflammation, as in the injection of irritants into the tunica vaginalis.

(*d*) **Into mucous cavities.**—Drugs are most frequently given by the **mouth**, to be absorbed from the mucous membrane of the stomach or intestines, but the rate of absorption is much slower than from the subcutaneous tissue, and will depend upon whether the drug is readily soluble in the gastro-intestinal secretions, and whether it is given on an empty stomach, in which case it will be quickly absorbed; or on a full one, when it will be slowly absorbed. Some drugs, given by the mouth and absorbed from the stomach or intestines, probably never reach the general circulation, as they are excreted in the bile by the liver. The drug should be in a pleasant palatable form, and, generally, so combined as not to irritate.

Drugs are sometimes given by the **rectum**—in a solid form as **suppositories**, in a liquid form as **enemata** or clysters; but they are neither dissolved nor absorbed here so quickly as in the upper part of the gastro-intestinal canal.

For local effects they may be given by the **urethra** or **vagina (injections, bougies, pessaries)**, or by the **respiratory passages (inhalations, cigarettes, sprays,** or **nebulæ** for **inhaling)**; **insufflations** for blowing into the throat and larynx; **pigmenta, gargles, lozenges,** for a local effect on the mouth and pharynx; **nasal douches** for the nose. For sprays an atomizer is required. Sometimes volatile drugs, as chloroform or amyl nitrite, are inhaled for their general effect.

(*e*) **By the skin.**—Some drugs may be absorbed from the skin if mixed with some fatty substance. In this way mercury may be absorbed by being rubbed in; but drugs are chiefly applied to the skin as ointments, plasters, &c., for their local effect.

Cataphoresis or **Ionization** is a means of introducing drugs through the skin. A large suitable pad soaked in a solution of the drug forms one pole of a galvanic battery. It is placed on the skin over the part, *e.g.* knee, to be influenced, and the other pole is placed on the skin near by. When the current flows the drug passes through the skin. When it is wished to introduce potassium iodide, sodium salicylate, both used for chronic affections of joints and nerves, or arsenious

acid used for psoriasis, the cathode is soaked in a solution of the drug. When it is wished to introduce cocaine, used to relieve pain, copper used for ringworm and uterine discharges, or zinc used as an antiseptic or for rodent ulcer and other chronic ulcers, the anode is soaked in a solution of the drug.

Drugs are also applied to the **eye** and **ear** as drops and washes.

DOSES.

The study of doses is termed **Posology**. In determining the dose the following considerations have to be borne in mind :

1. Age.—The adult dose is that for a person between twenty and sixty years old.

A common rule is, for **children** under twelve, to add twelve to the age, and divide the age by the number thus obtained. Thus for a child aged eight the dose will be $\frac{8}{8+12}=\frac{2}{5}$ of an adult dose. From twelve to sixteen years from $\frac{1}{2}$ to $\frac{2}{3}$ of the adult dose is required, and from seventeen to twenty years from $\frac{2}{3}$ to $\frac{4}{5}$. Dryer and Walker give the following :—

At 21 years . .	full dose	At 3–4 years . .	$\frac{1}{3}$ dose
„ 15 „ . . .	$\frac{3}{4}$ „	„ 1 year . .	$\frac{1}{4}$ „
„ 9–10 „ . . .	$\frac{1}{2}$ „	Early months .	$\frac{1}{10}$ „

There are exceptions to these rules for individual drugs ; *e.g.* children take iron, cod liver oil, arsenic, and chloral very well, but they can take only very small doses of opium.

Above sixty years of age the dose should slightly diminish as age increases.

2. Weight.—In pharmacological experiments the dose should always be expressed as a proportion of the weight of the animal. In man the weight is not often considered, for it depends so much upon bone and fat, which are not active tissues ; but, as a rule, women require rather a smaller dose of medicine than men.

3. Habit.—A man who is constantly under the action of a drug becomes very insusceptible to it. Thus an opium eater requires enormous doses of opium to produce any effect. A person who habitually takes purgatives requires very strong ones to open the bowels.

4. Idiosyncrasy.—The susceptibility to drugs varies very much. Some persons are salivated by minute doses of mercury, others bear it very well, and there is hardly a drug to which some people are not either exceptionally indifferent or susceptible.

5. Time of Administration.—Drugs all act to greatest advantage when given so that their effect will be produced at its natural time. Thus soporifics act best when given in the evening, slowly acting purgatives when given overnight,

quickly acting ones when given before breakfast, ergot when given during labour.

6. Mode of Administration.—We have seen that drugs are rapidly absorbed from the subcutaneous tissues. Therefore a smaller dose is required for subcutaneous injection than when the same drug is given by the mouth, for absorption is slow from the upper gastro-intestinal tract. It is usually slower still from the rectum, but there are many individual differences with different drugs; thus strychnine is not absorbed from the stomach, but is readily taken up from the pharynx and rectum, but prussic acid is readily absorbed from the stomach. Also certain drugs are excreted by the liver or destroyed in it when given by the stomach. Other things being equal, absorption takes place quickly with an empty, slowly with a full, viscus.

7. Mental Emotion.—Sometimes if the patient's mind is particularly fixed on the action of the drug a small dose is powerful. For example, often, if the patient is convinced he will sleep, a very small dose of morphine is all that may be required.

8. Temperature.—As the action of the drug on the organism is often partly chemical, the temperature must, in cold-blooded animals and excised structures, as muscle, &c., help to determine its action; but the temperature of man varies within so few degrees that this is not an important factor in medicine.

9. Preparation of Drug.—A smaller dose of a soluble preparation, as a tincture, will be required than of a solid preparation, as a pill, which will have to be slowly dissolved before absorption.

10. Rate of Excretion.—It is obvious that, other things being equal, a smaller dose will be required of a drug that is slowly excreted than of one which is rapidly excreted.

11. Cumulative Action.—Sometimes it is found that if a person has been taking a drug regularly, but without the production of any toxic symptoms, these will suddenly develope. This is said to be due to the cumulative action of the drug. It may be caused by the following circumstances:

(*a*) The drug may be absorbed more rapidly than it is excreted. This is the cause of the cumulative action of mercury and lead, both of which are excreted with difficulty by the kidney.

(*b*) There may be a sudden arrest in the excretion of the drug. It has been suggested that digitalis and strychnine, when the quantity of them in the tissues reaches a certain amount, contract the renal vessels, and hence excretion is arrested.

(*c*) It is possible that owing to an alteration in the intes-

tinal contents, a drug which was previously very slowly dissolved becomes quickly dissolved, and hence rapidly absorbed.

12. Disease.—The physiological action of drugs, and consequently the dose, are profoundly modified by disease. For example, a patient with peritonitis will bear enormous doses of opium. Antipyretics, which do not affect a normal temperature, powerfully depress a febrile temperature.

13. Species.—Different animals are often able to withstand largely different doses. Thus birds are very tolerant to opium, herbivora to atropine, and hedgehogs to many poisons, *e.g.* cantharides, and white rats are much more tolerant than brown to various toxins. This probably depends upon the different chemical composition of the tissues of various animals.

PRESCRIBING.

The more complex prescriptions consist of—

(1) The Basis, or principal active ingredient.
(2) The Adjuvans, or that which assists its action.
(3) The Corrigens, or that which corrects its operation.
(4) The Constituens, vehicle or excipient, which imparts an agreeable form.

Thus the object of every prescription is, if possible, to cure quickly, safely, and pleasantly. For example, in Pilula Colocynthidis et Hyoscyami the colocynth is the basis, the aloes and scammony form the adjuvans, and the extract of hyoscyamus is the corrigens to prevent the griping. In Mistura Cretæ the cinnamon water is the vehicle. Many drugs do not require anything to assist their action or correct their operation.

Incompatibility of ingredients should be particularly avoided in prescriptions. There are three kinds of incompatibility:

(*a*) *Chemical Incompatibility.* Usually when chemical incompatibility occurs in a prescription, it is due to interaction between two soluble salts leading to the formation of another salt. Sometimes chemical incompatibility is encountered designedly, for example, perchloride of mercury is often prescribed with potassium iodide, mercuric biniodide is formed, but is kept in solution by the excess of potassium iodide. Often, however, in careless prescriptions, the interaction of soluble salts leads to the formation of a salt which is insoluble in the mixture, and a precipitate falls to the bottom of the bottle. It is important to remember that **glucosides** should not be ordered with free acids, which decompose them; nor **alkaloids** or **alkaloidal salts** with

alkalies, alkaline salts, tannic acid, iodides, or bromides, for they precipitate them. Failure to remember this has caused death, all the alkaloid being swallowed in the last dose in the bottle.

With the following drugs it is **particularly difficult to avoid chemical incompatibility**:

Antipyrin.
Chlorine in solution.
Iodine in solution.
Liquid preparations of Iron.
Lead salts.
Zinc salts.
Silver salts.
Mercuric Chloride (especially).
All Iodides.
All Bromides.
Potassium Permanganate.
Potassium Acetate.
Nitrites.
Tannic Acid.
Gallic Acid.
Acidum Hydrocyanicum Dilutum.
Mineral Acids.
Liquor Potassæ.
Quinine Sulphate.
Guaiacum Tincture.

Substances rich in oxygen, as chlorates, iodates, permanganates, picrates, nitrates, and bichromates, should **not be mixed with readily oxidizable substances**, such as charcoal, sulphur, iodine, carbolic acid, glycerin, turpentine, and organic compounds generally, for explosive compounds are very liable to be formed.

Poisonous compounds may be formed by the admixture of substances in solution; *e.g.* potassium chlorate and the syrup of iodide of iron liberate iodine, dilute hydrocyanic acid and calomel form cyanide of mercury, potassium chlorate and potassium iodide form at the temperature of the body a poisonous compound, probably potassium iodate. Death has occurred owing to patients having taken some of these careless prescriptions.

If, in a mixture, incompatibles are inevitable, they should both be diluted with the vehicle before they are added to each other. The careful prescriber will avoid combining any of the above incompatible substances.

(*b*) *Physical Incompatibility.*—This occurs when the mixture of the substances will not form a clear solution; *e.g.* insoluble powders and oils will not mix with water, the addition of which to some spirits and all resinous tinctures, and to liquid extract of male fern, causes a precipitate; an acid mixture is flavoured with liquorice, but the acid precipitates glycyrrhizin; an alcoholic solution added to chloral causes all the chloral to rise to the top.

In such cases the solution may be **thickened** so that the precipitate is suspended in it **to form a suspension or an emulsion**, but even then the mixture must be shaken before a dose is taken. **Mucilage of acacia** is the best suspending agent. The substances incompatible with it are mentioned on

The following table, drawn up by Potter, shows the most important instances of solutions which mutually precipitate each other. p *means "forms a precipitate."*

	Alkaloidal solutions	Metallic solutions (generally)	[illegible]	[illegible]	Magnesium solutions	[illegible]
Solutions of alkalies	p	p	p	p	p	p
Tannic acid	p	p	p	—	—	
Carbonic acid and solutions of carbonates	p	p	p	p	p	
Sulphuric acid and solutions of sulphates	—	—	p	p		
Phosphoric acid and solutions of phosphates	p	p	p	p	p	
Boric acid and solutions of borates	p	p	p			
Hydrochloric acid and solutions of chlorides	—	—	p			
Hydrobromic acid and solutions of bromides	—	—	p			
Hydriodic acid and solutions of iodides	p	—	p			
Solutions of sulphides	—	p	p			
Arsenical solutions	—	p	p			
Albumen	—	p	p			

Examples of chemical incompatibility are the prescribing of (1) tannic acid [illegible] it with alkaloids or metallic salts, especially those of iron; (2) [illegible] prescribed with carbonates lead to the evolution of CO_2; (3) strychnine [illegible] sium bromide, and strychnine is precipitated; (4) chloral and alkalies [illegible] sulphate and potassium acetate together cause a voluminous precipitate of [illegible] water with mercury salts (this incompatibility is intentional in Lotio Nigra and Lotio Flava [illegible] oxides of mercury; it decomposes carbonates and bicarbonates of alkalies; [illegible] quinine and morphine salts; (7) mercuric chloride is incompatible with most [illegible].

p. 6. **Tragacanth** is often preferred, for it keeps better than acacia; the addition of a little almond oil improves the appearance of the mixture. It is used, for example, to suspend the guaiac resin in Mistura Guaiaci. **Indian Gum** resembles acacia.

1 pt. of most fixed oils requires	M. Acaciæ	$\frac{3}{4}$ pt.,	water	1 pt.
1 pt. of balsam of Peru	,,	2	,,	$1\frac{1}{2}$
1 pt. of oil of turpentine	,,	1	,,	1

Sometimes yolk of egg or milk is employed to form an emulsion or suspension. **Liquor Potassæ** much facilitates the admixture of fixed oils and water. This, for example, is the object of the Liquor Potassæ in Mistura Olei Ricini of B. P. 1885. It often, however, acts chemically on the ingredients of the prescription. Tincture of quillaia and tincture of senega, as they contain saponin (*q.v.*), aid the emulsification of any oil. Light carbonate of magnesium is employed to aid the diffusion of an oil in water, as in Vapor Olei Pini Sylvestris of B. P. 1885. Resinous tinctures require an emulsifying agent; an equal part of mucilage of acacia is the best. The suspension of oil of turpentine in mucilage of acacia is a common non-official example of an emulsion.

(c) *Pharmacological Incompatibility; e.g.* the combination of purgatives with astringents. Sometimes this is intentional, as in the occasional addition of atropine to a hypodermic solution of morphine. After the description of each drug, those that are incompatible with it will be enumerated.

THE PRESCRIPTION.

The details of a prescription should be written in the following order:

The *first* part is the *Superscription*, which is the sign ℞, an abbreviation for Recipe, "Take."

The *second* part is the *Inscription*, consisting of the names of the drugs in the genitive case (the vehicle in the accusative if "ad" is used with it), and their doses in the accusative.

The *third* part is the *Subscription*, that is to say, the directions to the dispenser. This in England and most other countries is sometimes written in Latin, but in France and the United States it is always in the native language.

The *fourth* part is the *Signature*, that is to say, the directions to the patient (from L. "Signetur," let it be labelled). This is written in English.

The *fifth* part consists of the doctor's name or initials at the bottom on the right, the patient's name at the bottom on the left, and under it the date; thus:

Take one tablespoonful thrice a day, two hours after meals.

William Smith, Esq. A. B. C.

16th June, 1914.

s, ss, and *fs* are abbreviations for semi, a half, and aa for ana, of each.

The following is a prescription for a pill:

℞ Extracti Nucis Vomicæ Sicci gr. ¼.

Extracti Euonymi } āā gr. *fs*.
Aloini }

Hydrargyri Subchloridi gr. j.

Extractum Hyoscyami ad gr. v.

Fiat pilula. Mitte 24.

Take one immediately before dinner every evening.

William Smith, Esq. A. B. C.

11th Nov., 1914.

It will be observed that the quantities in the prescription are for one pill only, and the chemist is directed to send 24. Often, however, the prescription is written with the quantity of each ingredient necessary to make the full number of pills. Thus:

℞ Extracti Nucis Vomicæ Sicci gr. vj.

Extracti Euonymi } āā gr. xij.
Aloini }

Hydrargyri Subchloridi gr. xxiv.

Extractum Hyoscyami ad gr. cxx.

Fiant pilulæ 24.

Take one immediately before dinner every evening.
William Smith, Esq. A. B. C.
11th Nov., 1914.

Prescriptions for powders are also written in either way.

The following is a metric prescription such as would be used on the Continent. The quantities, either of fluids or solids, are expressed in grammes, so that the abbreviation gm. for this word is omitted.

℞	Magnesiæ Sulphatis . . .	30
	Acidi Sulphurici Diluti . . .	0·6
	Syrupi Limonis	30
	Aquæ	180

Fiat haustus.
To be taken on rising in the morning.
William Smith, Esq. A. B. C.
22 Jan., 1914.

The medicine may be prescribed as a **pill** when it is required that the patient shall carry it about with him, when only a small dose is needed, when it is desirable that it shall act slowly, when it is required to act on the lower bowel, when it is insoluble or nauseous, or when it is difficult to prescribe in the liquid form. Kaolin is the best basis for substances, as permanganate of potassium, which are decomposed by contact with organic matter.

Oils, and volatile, deliquescent, or bulky substances should not be prescribed as pills, as they require much solid excipient; nor should pills be used for substances required to act immediately. Insoluble or very nasty powders are often best given in *cachets*.

If it is required to give the drug in an *effervescing* draught or mixture, an alkaline carbonate is prescribed with the mixture containing the drug, while a solution of citric acid (*q.v.*) or tartaric acid (*q.v.*) is prescribed in a separate bottle. A dose from one bottle is mixed with a dose from the other, the acid acting on the carbonate liberates carbonic acid gas, hence the mixture effervesces. It should be drunk before effervescence has passed off

Abbreviations should be employed as little as possible. The edition of the "British Pharmacopœia" published 1914 is the first giving an abbreviation for each official substance and preparation. Serious mistakes have happened because the abbreviations have been ambiguous. The following are especially to be avoided:

Acid. Hydroc. (may be either Acidum Hydrochloricum or Acidum Hydrocyanicum).

Ext. Col.	(may be either	Extractum Colchici or Extractum Colocynthidis).
Hyd. Chlor.	(„ „	Calomel, Corrosive sublimate, or Chloral hydrate)
Hyd.	(„ „	*Hydrargyrum*, *Hydras*, *Hydriodas*, *Hydrochloras*, *Hydrochloridum*, or *Hydrocyanicus*).
Sulph.	(„ „	Sulphur, Sulphide, Sulphate, or Sulphite).

Sometimes the signature is written in Latin, and it is often abbreviated. A list of abbreviations is in the Appendix.

In Great Britain it is understood, unless otherwise stated, that preparations are those of the British Pharmacopœia.

Ad.—Be careful in deciding whether or not to use this word before the vehicle. If it had been left out in the prescription on p. 39, the bulk of the mixture would have been nearly $10\frac{1}{2}$ fluid ounces, and the amount of the ingredients in each dose would have been less than was intended.

Dispensing the Prescription.—The dispensor should bear the following rules in mind:—(1) Read the prescription through first. (2) Next write the directions, so that they have time to dry. (3) Solution by heat should not be used if more of the salt is ordered than will dissolve in cold water. In such a case it must be suspended. (4) With fluids, measure them in such an order that the measure-glass shall be finally rinsed out with the vehicle. (5) Use glass scale pans. (6) Clean and put away everything directly after use. (7) If in the slightest doubt ask the prescriber. (8) If finally the prescription contains any insoluble matter, label "Shake the bottle." (9) If the medicine is very poisonous, label it as such and use a distinctive bottle. (10) If for outward application only, say so. (11) In dispensing substances chemically incompatible, if there is any likelihood that the new body formed is dangerous, communicate with the prescriber before dispensing (*e.g.* potassium iodide prescribed with Spiritus Ætheris Nitrosi forms free iodine; alkaloids are precipitated by alkalies). Otherwise keep the incompatibles as far apart as possible by diluting each with the vehicle before mixing.

Dangerous Drugs Act.—The following regulations under this Act came into force on September 1, 1921. They apply to Morphine, Diamorphine (Heroin), Cocaine, Ecgonine, their respective salts, medicinal Opium, and any preparation or admixture containing not less than 0·2 per cent. of anhydrous morphine or 0·1 per cent. of cocaine, ecgonine or

diamorphine. They state that prescriptions containing a larger proportion of these drugs must comply with the following conditions: (1) If an official form is available the prescription must be written on this, if not available the prescription must be marked "Official form not available." (2) Prescriptions must be in writing. (3) Must be signed with full name and address of prescriber. (4) Must specify the name and address of the person for whom intended. (5) Must specify the total amount of the drug to be supplied.

The following table of dilutions furnishes examples of the maximum strength of a mixture which is outside the Act:

Chlorodyne, B. P. C.	190 m.	per fl. oz.
Cocaine Hydrochlor.	$\frac{1}{2}$ grn.	"
Diamorphine Hydrochlor.	$\frac{1}{2}$ grn.	"
Liq. Morph. Acet.	120 m.	"
" " Hyd.	106 m.	"
Tinct. Opii	95 m.	"
Tinct. Chloroformi et Morphin. Co.	95 m.	"
Morphin. Acetate	$1\frac{1}{5}$ grn.	"
" Hydrochlor.	$1\frac{1}{4}$ grn.	"
" Sulphate	$1\frac{1}{4}$ grn.	"
" Tartrate	$1\frac{1}{4}$ grn.	"

PHARMACOLOGICAL AND THERAPEUTICAL ACTIONS.

When the action of a drug is spoken of, the physiological action is usually understood.

The primary action is that due to the unaltered drug; *e.g.* the emetic action of sulphate of zinc.

The secondary action is that due to compounds formed from the drug whilst in the body; *e.g.* the antiseptic effect on the urine of Uva Ursi taken by the mouth is by some thought to be due to the fact that arbutin, its active principle, is in its passage through the kidney decomposed into a glucoside and hydroquinone, and the latter is a powerful antiseptic.

The direct or local action of a drug is that produced on any organ with which it comes in contact; *e.g.* the cantharidin in cantharides, in being excreted through the kidneys causes inflammation of them.

The indirect or remote action is a secondary effect, the result of the direct effect; *e.g.* curare paralyses the respiratory muscles, consequently the blood becomes venous, and therefore convulsions take place. The venosity and the convulsions are each indirect actions of curare.

It is clear that, among drugs acting on similar parts, the total effect will depend very much upon which part is first affected. For example, atropine and curare paralyse motor nerves, but atropine first affects the ends of the vagus, and only late in its action the motor nerves of the voluntary and respiratory muscles; hence paralysis and asphyxia are late, and a rapid pulse is an early symptom. Curare, however, early affects the nerve-endings of the voluntary and respiratory muscles, and the heart towards the end; therefore asphyxia and paralysis occur early, and a rapid pulse is a late symptom.

Relation between Chemical Constitution and Physiological Action.—There is no doubt that the physiological action of a drug often depends upon its chemical constitution. Naturally, substances which are broken up in the body in such a way as to lead to the liberation of a common element or group will have a similar action. The action of a drug also depends upon electrolytic dissociation of its solutions, and then the effect depends upon which ion is the more poisonous. For example, the hydrochloride and sulphate of strychnine will have the same action owing to the intensity of action of the strychnine ion, and because the chlorine and sulphate ions can be disregarded, for the animal would be killed by the strychnine ion before enough of the chloride or sulphate ions could be given to have any influence. But with sodium chloride and sodium sulphate the action is quite different, because, the sodium being almost harmless, sufficient quantity of the drugs can be given for the chlorine and sulphate ions to have their separate effects.

Instances in which chemical constitution obviously influences action are the similarity of effects of nitrites, the fact that all chlorides, bromides, and iodides of ethane and methane are anæsthetic, the similarity of action of iodides of many metals and the similarity of action of bromides of many metals.

Substitution of one radical for another in organic compounds often strikingly modifies their action; for example, if strychnine, brucine, and thebaine are converted into methylstrychnine, methylbrucine, and methylthebaine, the convulsive action of each of the first three substances is replaced by a paralysing action. The effect of substitution may be also well seen in the various derivatives of atropine and cocaine, and in the relation of aconitine (*q.v.*) to benzaconine and aconine. Another very interesting case in point is that methyl glucoside is sweet, ethyl glucoside is somewhat sweet, phenyl glucoside is bitter, and benzyl glucoside is intensely bitter.

Sometimes the position of the radicals in the molecule is of great physiological importance: thus resorcin

(metadihydroxybenzene) is very sweet, whilst pyrocatechin (orthodihydroxybenzene) is bitter.

Sometimes the molecular weight appears to influence the intensity of action, for the relative toxicity of various alcohols is as follows: methyl alcohol, 0·8; ethyl alcohol, 1·0; propyl alcohol, 2·0; butyl alcohol, 3·0; amyl alcohol, 4·0.

The difficulty of the whole subject is, however, so great that it is impossible at present to lay down any laws sufficiently general to be of any use to the beginner. It must be remembered that dissimilarity of action is often more apparent than real, for it may be due to varying solubility, digestibility, rate of absorption, rate of elimination, or rate of diffusion, also to the organ which happens to be first affected, and the degree to which the drug can dissolve the constituents of tissues.

Relation between Physical Condition and Physiological Action.—The physical condition must obviously influence the action. For example, a volatile drug can act directly on the respiratory mucous membrane, and it can be absorbed very rapidly. Drugs insoluble in the gastro-intestinal fluids act very slowly unless given in solution. Again, the rate and direction of diffusion must depend upon whether the solution of the drug is isotonic, hypotonic, or hypertonic as regards the fluid, usually within cells, with which its solution is diffusing. But often the action of physical laws is apparently interfered with by selective action of cells, in which case the drug must enter into chemical combination with the affected cells. Sometimes this selective action is very striking; for example, alcohol and lead both produce peripheral neuritis, but alcohol chiefly affects the anterior tibial nerve, whilst lead affects the musculo-spiral. Inasmuch as the results of diffusion are best seen with solutions of salts of alkaline metals, effects on the body which result from diffusion are said to be due to "*salt action.*"

Colloidal Solutions or Collosols.—These solutions are suspensions of minute particles of a substance in the colloidal state (i.e. they are amorphous and diffuse with difficulty). Many substances, chiefly metals, can, it is now known, exist in both colloidal and crystalloid states. In order to remain in the colloidal state metals in colloidal solution require in the solution some organic colloid, *e.g.* albumin. Collosols can be made either chemically or electrically. When the solvent is water the colloidal solution is sometimes called a hydrosol. Collosols of iodine, silver and sulphur have been used externally for skin diseases. Injected subcutaneously they produce a leucocytosis. Large doses can be given by the mouth, for substances in the colloidal form can only be absorbed

slowly. Collosols of silver and mercury, and to a less extent of other metals, have been given internally. There is no evidence that the therapeutic effect of drugs in the colloidal state is better than that of the same drugs in the crystalloid state.

Drugs may be classified according to the parts on which they act, and before describing each individual drug a classification on this principle will be given.

Division I.—Drugs acting upon Organisms which infest the Human Body, or upon Processes going on outside it.

Antiseptics are drugs which arrest putrefaction, either by preventing the growth of, or completely destroying, the micro-organisms on which decomposition depends. Some authors limit the use of the word to those drugs which prevent the growth of micro-organisms, and call those substances which destroy the micro-organisms disinfectants.

Statements are most discordant as to whether certain substances are antiseptics, and as to their antiseptic power. This is because antiseptics act differently on different organisms; and the distinction has not been drawn between preventing the growth of and destroying micro-organisms. Also because the power of antiseptics depends upon the temperature at which they act, the medium in which they are dissolved, the strength of the solution, the time given them to act, and the number of micro-organisms present in the substance to which they are added.

To properly test the value of an antiseptic the above conditions must be noted. All instruments and substances—except the fluid containing the micro-organisms to be tested—are heated so that any adventitious micro-organisms are destroyed. A cultivating medium in which the micro-organisms will grow is selected, and two test-tubes, each containing some of it, are taken; to one of these the supposed antiseptic is added. Some fluid containing the micro-organisms is then added to both test-tubes; both are plugged with sterilized cotton wool

to prevent the entrance of germs from the air, and it is observed whether the micro-organisms will grow in the tube containing no antiseptic, but not in that containing the antiseptic. Phenol is usually taken as the standard.

But after testing in a laboratory we do not know the clinical value of an antiseptic. Many lose much power if dissolved in oil or glycerin, or in the presence of protein, *e.g.* serum, many retard phagocytosis, or are too irritant, or are toxic when absorbed. Aqueous solutions of Flavine (*Synonym.*—Acriflavine) and Brilliant Green have these defects in but slight degree. Flavine is the better and has a stimulating effect on connective tissue cells.

As the power of an antiseptic depends on so many circumstances, no exact order of their potency can be given, but roughly the more powerful are placed first in the following list:

1. **Heat.**—This is the best antiseptic, but a temperature of at least 100° C. is usually required. After an infectious fever, clothing, bedding, &c., may be heated in a dry air chamber to between 100° and 150° C.; or what is far better, as dry air does not penetrate the spores nearly as well as moist, and the interior of the rolls of fabrics often hardly gets heated at all, steam under pressure may be driven through them. Another useful way is to boil the infected things in water. Surgical instruments are disinfected in this way.

2. **Flavine.** *Synonym.*—Acriflavine.

3. **Brilliant Green.**—(*see* above).

4. **Perchloride of Mercury.**—A solution of 1 in 1000 is constantly used for washing hands, and many other purposes connected with midwifery and surgical operations.

5. **Chlorine.**—Chlorine gas, disengaged by the action of hydrochloric acid on black oxide of manganese, may be used to disinfect a room, the windows, chimneys, and doors of which are pasted up. Disengaged from chlorinated lime, it is used to disinfect and deodorize urinals. Used as one of the many hypochlorite solutions it is a most powerful antiseptic for surgical purposes. It must be remembered that it attacks and bleaches many substances.

6. **Bromine,** and 7, **Iodine vapours** are rarely used, as

they are too irritating, but tincture of iodine is frequently painted on the skin to disinfect it before operations.

8. **Iodoform** yields iodine when in contact with animal tissues and so acts as an antiseptic.

9. **Carbolic acid** and its derivatives are largely used.

10. **Cresol** and its allies are very powerful and much used.

11. **Creosote**, 12, **Thymol**, and 13, **Naphthol** are as powerful as carbolic acid, but far less soluble in water.

14. **Salicylic acid**, 15, **Resorcin**, 16, **Quinine**, 17, **Oleum Eucalypti** and other essential oils and oleo resins.

18. **Balsam of Tolu**, 19, **Balsam of Peru**, 20, **Benzoin** are powerful but too expensive for general use.

21. **Peroxide of hydrogen** is used in surgery. It is also the active ingredient of Sanitas.

22. **Sulphur dioxide**, formed by burning sulphur, is used to disinfect rooms.

23. **Boric acid** is feeble, but, as it is not irritating, it is widely used for surgical purposes and for preserving food.

24. **Permanganate of potassium**, and 25, **Chloride of zinc** are used domestically.

26. **Sulphate of zinc**, 27, **Sulphate of copper**, 28, **Nitrate of silver**, 29, **Potassium bichromate**.

30. Strong acids and alkalies such as **hydrochloric acid** and **caustic potash**.

31. **Alcohol** is antiseptic only in strong solution.

Dixon gives the following useful classification of the way in which antiseptics act:—

(*a*) Salt action. These by osmosis extract water from micro-organisms and so kill them, *e.g.* common salt (used for preserving meat) and sugar (for preserving fruit).
(*b*) Oxidation, *e.g.* potassium permanganate. Chlorine, bromine, and iodine act in the presence of water by abstracting hydrogen.
(*c*) Reduction, *e.g.* sulphur dioxide in the presence of water, and formic aldehyde, which, however, also combines with proteins.
(*d*) Precipitation of proteins, *e.g.* many metals by acting directly on the micro-organisms and also on their food in solution.
(*e*) Protoplasmic poisons, *e.g.* coal-tar products.

We do not know of any drugs which, when taken internally or inhaled, will certainly destroy micro-organisms, either in the gastro-intestinal tract or

respiratory passages, unless they are sufficiently concentrated to be fatal to the patient. Some authorities, however, consider that naphthol, calomel, cyllin, and certain other substances will destroy micro-organisms in the stomach and intestines, cyllin being the most active. As the ethereal sulphates in the urine are increased by bacterial action in the intestine, they form a gauge of the efficacy of intestinal antiseptics, and it is said they are a little decreased by these drugs. Many attempts have been made to combat diseases due to micro-organisms by the injection of antiseptics into the blood, (*e.g.* quinine for malaria, arsenic for syphilis), but not always with success.

Deodorants or deodorizers are substances which destroy disagreeable smells. There are too many for enumeration. Many antiseptics are deodorizers.

Antizymotics.—This is a word sometimes applied to drugs which arrest fermentation.

Anthelmintics are drugs which destroy such parasitic worms as infest the alimentary canal. Four kinds only are usual in England.

(1) Tapeworm (*Tænia solium* and *T. mediocanellata*). Anthelmintics: **Filix Mas** (mostly used), **Oleum Terebinthinæ, Cusso, Pelletierine, Melon Pumpkin Seeds, Embelia.**

(2) Roundworm (*Ascaris lumbricoides*). Anthelmintics: **Santonin** (probably more a vermifuge). **Butea Seeds.**

(3) Threadworm (*Oxyuris vermicularis*). Anthelmintics: Rectal injections of **salt water, infusion of quassia, solutions of iron salts,** or **diluted oil of turpentine.** It is doubtful whether these drugs (except turpentine) relieve the patient by killing the threadworms which inhabit the rectum, or merely render this part unfit for them by removal of mucus.

(4) Hookworm (*Ankylostoma duodenale*). Rather rare in this country. Anthelmintic: **Thymol.**

Anthelmintics for the tape- or round-worm should be given when the alimentary tract is empty. Hence it is a good plan to give a dose of castor oil a few hours before the anthelmintic, so as to ensure that the drug comes in contact with the worm. To

expel the parasite a purgative should be given a few hours after the anthelmintic. Purgatives so used are called **Vermifuges**. **Vermicide** is a term applied to drugs which kill intestinal entozoa.

Antiparasitics or **parasiticides** are substances which destroy parasites. The term is usually applied to those which destroy parasites infesting the skin.

(1) For the various forms of tinea the following are used:—**Mercurial** preparations, especially the oleate, tincture of **iodine**, glycerin of **carbolic acid**, an ointment of **pyrogallic acid**, a **boric acid** lotion, **salicylic acid** lotion, **acidum sulphurosum**, **formaldehyde**, and **thymol**; and if the patches are small, severe irritants, as **croton oil**, **cantharidin**, and **chrysarobin** ointment. *T. versicolor* never requires severe irritants.

(2) As a parasiticide for itch, **sulphur** ointment is generally used. **Balsam of Peru** and **Storax** are also effectual.

(3) Pediculi vestimentorum will be killed by any mild parasiticide. Unguentum **Staphisagriæ** is often used.

(4) Pediculi capitis and pediculi pubis are also easily killed by mild parasiticides; **mercurials** are commonly employed, so is Unguentum **Staphisagriæ**.

Antiperiodics are drugs which arrest the return of diseases which recur periodically. They probably act by forming, after action on the tissues of the host, a poison to the micro-organism causing the disease.

They are **cinchona bark**, its **quinine** and other alkaloids (by far the most powerful), **arsenious acid**, **eucalyptus**, **hydrastis**, **salicin**, and **salicylic acid**. They are used for all forms of malarial fever and neuralgia.

Division II.—Drugs acting on the Blood.

A. Drugs acting on the Plasma.—Many substances must after absorption exist in solution in the plasma, and purgatives, diuretics, and diaphoretics must alter the composition of the plasma by abstracting substances from it. Only very slight changes in the reaction of plasma, which is normally practically neutral, are compatible with life. It is never necessary to make the plasma more acid, and any excess of alkali is neutralised by carbonic acid,

but in certain conditions there is believed to be an excess of acid, which requires neutralisation. This is done by means of the carbonates, citrates, or tartrates of the following metals :—

(1) **Potassium.**	(4) **Lithium.**
(2) **Sodium.**	(5) **Magnesium.**
(3) **Ammonium.**	(6) **Calcium.**

The citrates and tartrates of these metals are oxidised in the body to alkaline carbonates.

Therapeutics.—Alkalies are used to reduce the acidosis of diabetic coma and other conditions, sodium bicarbonate being usually selected. They are also given in gout in the hope of increasing the solubility of uric acid in the plasma. As the treatment is prolonged, a preparation which does not upset digestion, such as potassium citrate or lithium citrate, is usually preferred. Both potassium and lithium urates are more soluble than the sodium urate, but the change produced in the composition of the plasma must be very slight. The excretion of potassium and lithium carbonates in the urine, which results, aids the excretion of uric acid by causing diuresis, and not, as was formerly thought, by increasing its solubility. Natural alkaline waters are frequently prescribed.

In *lead-poisoning* the lead is locked up in the tissues in a very sparingly soluble form. Potassium iodide is given because some authorities believe it increases the solubility of lead in the plasma, and consequently facilitates its excretion by the kidneys.

Alkalies have been largely used in *rheumatic fever*, on the assumption that there is a deleterious agent in the plasma, and that its solubility is increased by increasing the alkalinity of the plasma; but this treatment has now been abandoned in favour of that by salicylates. For the same theoretical reason alkalies have been given in rheumatoid arthritis.

Purgatives, diaphoretics, and *diuretics* necessarily alter the composition of the plasma, and are largely used when there is much œdema of any part, or effusion into serous cavities, in the hope that as fast as these remedies drain off fluid from the plasma it will be replaced by that which is effused pathologically. Also they are given in conditions, as uræmia, in which it is thought that there are poisons in the blood, in order that their excretion may be hastened.

The composition of the plasma can also be altered directly either by venesection or transfusion.

B. Drugs acting on the Red Corpuscles.—The most important are those which can increase the amount of hæmoglobin when that is deficient. Strictly speaking, all these have a pathological and not a physiological action, for we know of no drugs which will increase the amount of iron in perfectly healthy blood. These drugs are called hæmatinics. They are—

(1) **Iron and its salts.**	(2) **Arsenious acid.**

They not only increase the quantity of hæmoglobin in each corpuscle, but also the number of red corpuscles. Their action is much aided by good food, fresh air, and attention to the general health, and especially to the digestive organs. The mode of action of these hæmatinics is very obscure, and will be discussed under each drug. Iron is by far the most important and effectual.

Potassium permanganate, salts of copper, hydrochloric acid, potassium salts and phosphorus have been incorrectly termed hæmatinics.

Indirect hæmatinics are drugs which benefit the patient by removing some obvious cause for his deficiency in hæmoglobin, or anæmia, as it is generally termed. Such are mercury, given for syphilis, quinine for ague.

The size of the red blood-corpuscles is said to be diminished by carbonic acid, quinine, and morphine, and to be increased by oxygen and hydrocyanic acid, and their number is said to be increased by small doses of mercury.

There are some drugs which are not employed therapeutically for their action on the blood, which are nevertheless very important physiologically and toxicologically, for they kill by altering the composition of the hæmoglobin, thus preventing its uniting with oxygen. Such are carbonic oxide, which displaces the oxygen from oxyhæmoglobin forming carboxyhæmoglobin. Potassium chlorate, acetanilide, phenazone, phenacetin, pyrogallic acid, potassium permanganate, and nitrites, especially nitrites, convert the hæmoglobin into methæmoglobin, and destroy the red corpuscles.

Phosphorus, sulphuretted hydrogen, turpentine, iodine, and sulphur also reduce oxyhæmoglobin. Phosphorus is especially destructive to the blood.

When freshly drawn blood is exposed to the air its oxidization is diminished by hydrocyanic acid, alcohol, chloroform, quinine, morphine, nicotine, strychnine, and brucine.

C. Drugs acting on the White Corpuscles.—Most if not all drugs which are poisons to amœbæ are poisons to white corpuscles when applied in sufficient strength, which, however, is rarely the case in the human body. All irritants which set up inflammation cause the white blood-corpuscles to wander through the capillary walls; and all the cinchona alkaloids have the power of arresting this migration: of these, quinine is the most powerful. Acetanilide is also powerful. If the quinine is circulating in the capillaries, it prevents the white corpuscles from wandering out; if it is applied to the outside of the vessels, it prevents the corpuscles from wandering away from the vessel through the wall of which they have passed. Arsenic increases the red marrow and

leads to the formation of many erythroblasts and myelocytes.

Veratrine applied to white corpuscles outside the body kills them.

Camphor, myrrh, and other aromatics increase their production by increasing absorption from the intestine. Benzoic acid and large doses of colchicum increase the number of polymorphonuclear cells. Small doses of colchicum diminish them.

D. Drugs altering the Coagulability of the Blood.

Those which increase it:—

CALCIUM SALTS, especially the CHLORIDE and LACTATE; MILK, in virtue of its calcium salts; MAGNESIUM OR STRONTIUM CARBONATE OR LACTATE; CO_2.

Those which diminish it:—

CITRIC ACID; ALCOHOL; BILE; large quantities of fluid; OXYGEN.

Therapeutics.—Calcium chloride or lactate is largely given to increase coagulation when bleeding is severe, *e.g.* in operations on jaundiced patients, or in hæmoptysis, or when for other reasons increased coagulability is desired, *e.g.* aneurysm, but the therapeutic use of calcium salts is, except in jaundice, disappointing. Citrates have been used to diminish the coagulability in thrombosis and embolism but without obvious good effect.

Division III.—Drugs acting on the Cardiac Mechanism.

The heart is capable of spontaneously originating impulses which in health begin in the sinus venosus, and spread downwards over the auricle and the ventricle to the apex. It used to be considered that these movements were due to spontaneous impulses proceeding from the cardiac ganglia surrounding chiefly the entrance of the superior and inferior venæ

cavæ, the entrance of the pulmonary veins, and the auriculo-ventricular groove; but we now know that there is no certain evidence that these ganglia originate impulses, and most of the evidence goes to show that the contraction of the muscular fibres is due to spontaneous impulses arising in them. This contractile power of the muscular fibres can be inhibited by the vagus, the fibres of which proceed from the vagal nucleus in the medulla, and can be augmented by the augmentor or accelerator nerve-fibres, which proceed downwards in the cervical spinal cord to the upper dorsal nerves, from which they pass through the first thoracic ganglion to the sympathetic, and so to the cardiac plexus, and thence to the heart. We are ignorant of any function for the cardiac ganglia; we know that medullated nerve-fibres lose their medulla in them, and that more fibres proceed from them than enter them. Possibly they have a nutritive function. We have therefore only to consider the action of drugs on the muscular substance of the heart, on the vagal or inhibitory fibres, on the vagal centre, on the augmentor, accelerator, or sympathetic fibres, and on the accelerator centre. The centres are remarkably easily affected by afferent impulses, proceeding from the heart itself or from almost any part of the body. Our information concerning the action of drugs on the heart of man is necessarily rather inexact, for many experiments are difficult to perform upon the mammalian heart, consequently the cold-blooded animals have been largely used; and as some differences are observed among them—for example, between the frog and the tortoise—it is probable that the deductions drawn from experiments upon the hearts of warm-blooded animals are not wholly applicable to man. In the following account of drugs the action described is that of a moderate dose; the action of a very large dose is generally the reverse of that of a moderate dose.

A. **Drugs acting upon the Heart directly.**—Our knowledge of these has been gained by studying the action of drugs upon excised hearts or pieces of the heart, and the action of drugs locally applied to the heart, either by gently applying a solution externally, or internally by means of a perfusion cannula. It is difficult to decide whether a drug acts upon the muscular fibre itself, or upon the fine nerves between these fibres, so that no attempt will here be made to distinguish between these actions. As the apex of the heart contains fewer nerves than the rest of the organ, it has been concluded that if a drug acts upon the apex, when it is cut off from the remainder of the heart it acts upon the muscle only; but it would be difficult absolutely to deny the existence of fine nerve-fibres in the apex. The vagus or inhibitory nervous mechanism has been much more studied than the accelerating. The effect of stimulating the muscle may be either to increase the rate or the force of the beat, or to do both; that of stimulating the vagus or its terminations in the heart will be either to diminish the rate or the force of the beat, or both; and the effect of stimulating the accelerator fibres will be just the opposite; and in each of these three cases the effect of paralysing will be the reverse of stimulating. The distinction between a stimulating effect on the terminations of the vagus and a depressing effect on the terminations of the accelerator nerves might be determined by observing the effect of stimulation of each of these nerves before and after the local application of the drug, provided that it has been shown that the muscle itself is not affected by the drug; but this is often difficult to prove. It is easily seen that the complexity of the problem is so great that it will be most convenient to classify the drugs which act locally on the heart by the effect they produce, without attempting to say whether they act on the muscle or nerve terminations.

Drugs increasing the force of the contraction:

(1) **Digitalis.**	(6) **Veratrine.**
(2) **Strophanthus.**	(7) **Erythrophlœum.**
(3) **Squill.**	(8) **Barium Salts.**
(4) **Convallaria Majalis.**	(9) **Suprarenal extract.**
(5) **Apocynum.**	(10) **Physostigmine.**

(In large doses these drugs in frogs always cause arrest of heart in systole; in mammals the final arrest may be in diastole with some, *e.g.* digitalis. **They all slow the pulse.**)

Drugs an important action of which is to increase the rate of the cardiac beat:

(1) **Atropine.**	(4) **Cocaine.**
(2) **Hyoscyamine.**	(5) **Caffeine.**
(3) **Duboisine.**	

Drugs an important action of which is to slow the rate of the cardiac beat (see also first list given above):

(1) **Muscarine.**	(2) **Pilocarpine.**

Drugs which increase both the force and the number of the beats, acting mostly reflexly:

(1) **Alcohol.**	(4) **Anæsthetics.**
(2) **Ether.**	(5) **Quinine.**
(3) **Chloroform.**	

Drugs which markedly decrease both the force and the number of the beats (these are called cardiac depressants):

(1) **Hydrocyanic acid.**	(9) **Emetine.**
(2) **Aconite.**	(10) **Muscarine.**
(3) **Veratrine.**	(11) **Pilocarpine.**
(4) **Antimony.**	(12) **Phenazone.**
(5) **Arsenic.**	(13) **Acetanilide.**
(6) **Saponine.**	(14) **Phenacetin.**
(7) **Chloral hydrate.**	(15) **Lobelia.**
(8) **Bromides.**	

Alcohol, chloroform, salicylates, and apomorphine, all in large doses.

B. Drugs acting on the Vagus Centre.—If we observe that the giving of a drug to an animal alters the beat of the heart, but that this alteration can be done away with, either by cutting the vagi or stimulating the peripheral end of the nerve—if one only

of them be cut—we may conclude that the drug acted on the vagus centre in the medulla. The excitability of the vagus centre depends so much upon the venosity of the blood and the blood-pressure, and so many drugs that act directly on it also act on other parts of the cardiac apparatus, that a complete list of those influencing it cannot be given. The following are the chief, and reference to the individual drugs will show whether the vagus centre is the most important part of the cardiac apparatus which is affected, and also the period of action of the drug in which the centre is affected.

Drugs which stimulate the vagus centre ; that is to say, the pulse is slowed, but this slowing disappears on section of the vagi :

(1) **Aconite.**
(2) **Veratrine.**
(3) **Digitalis.**
(4) **Strophanthus.**
(5) **Squill.**
(6) **Convallaria Majalis.**
(7) **Apocynum.**
(8) **Hydrocyanic acid.**
(9) **Chloroform.**
(10) **Hydrastis.**
(11) **Suprarenal extract.**
(12) **Pituitary (posterior part) extract.**
(13) **Staphisagria (Delphinine).**
(14) **Atropine.**
(15) **Hyoscyamine.**
(These last three only very early in their action.)
(16) **Increased blood-pressure.**
(17) **Venous blood.**

Drugs which depress the vagus centre : Large doses of some of the drugs mentioned in the last list, and drugs which diminish the blood-pressure, such as amyl nitrite and cocaine.

C. Drugs acting on the Accelerating Centre.—We know very little of drugs which depress this. The following probably stimulate it, for their administration renders the pulse still more rapid after the vagi have been cut :—

(1) **Ammonia.**
(2) **Apomorphine.**

D. Drugs acting on Cardiac Nerve Ganglia.—These first slightly stimulate and then profoundly paralyse all nerve ganglia. In the case of the heart, they act chiefly on the vagal ganglia, and so the pulse is at first a little slowed, but soon it becomes rapid, weak, and irregular:—

(1) **Nicotine.**
(2) **Coniine.**
(3) **Lobelia.**
(4) **Gelsemium.**

Therapeutics.—The drugs most used for their action on the heart are digitalis, squill, strophanthus, convallaria majalis, caffeine, alcohol, ether, chloroform, strychnine, belladonna, aconite, antimony, and hydrocyanic acid. The therapeutic indication for each of these drugs will be found given under the individual drug.

Division IV.—Drugs acting on the Vessels.

These are usually studied either by directly observing alterations in the size of the vessels in some thin structure, such as the ear of a rabbit, the mesentery, tongue, lung, web, or mylo-hyoid of a frog, or the wing of a bat; or the rate of the flow may be observed. This can be conveniently done by cutting some part, as the toes of a frog, and noticing the rate at which the blood flows from the cut vessels with and without the administration of the drug to the animal. It is often necessary that an artificial circulation should be maintained; for, if not, it might be difficult to prove that the alteration in the quantity of blood flowing from the cut surface was not due to *influences acting on the cardiac mechanism. In order* to determine if the changes are due to local or central effects, it is necessary to destroy the spinal cord, or to cut the nerves going to the part. When a drug is applied locally, as to the mesentery, and the vessels alter, if the nerves going to the part are not cut, it is difficult to say whether this alteration is direct or reflex.

Drugs are applied to the interior of vessels by injecting them into the circulation.

We know that each vessel is controlled by vaso-constrictor and vaso-dilator nerves, and that these proceed by different paths from the central nervous system, but we do not know upon which set of nerves drugs act; probably some upon the vaso-constrictor, and some upon the vaso-dilator. We can only classify the drugs into those which dilate or contract the vessels by local action, and those which produce these effects through their action on the central nervous system. When a drug acts locally we cannot tell whether it acts on the muscle in the wall of the vessel, or on the nerve terminations.

It of course follows that drugs acting on the heart, or on a large vascular area, will considerably modify the blood-pressure.

A. Drugs acting locally on Vessels.

Drugs which, when locally applied to vessels, dilate them:

(1) **Liquor ammoniæ.**
(2) **Silver nitrate** (strong).
(3) **Zinc chloride** (strong).
(4) **Copper sulphate** (strong).
(5) **Mercuric nitrate.**
(6) **Arsenious acid.**
(7) **Tartarated antimony.**
(8) **Iodine.**
(9) **Chlorine.**
(10) **Mineral acids** (strong).
(11) **Alcohol.**
(12) **Ether.**
(13) **Chloroform.**
(The last three if prevented from evaporating).

(14) **Carbolic acid.**
(15) **Creosote.**
(16) **All volatile oils,** as oil of turpentine, and many substances containing them, as mustard, Armoraciæ Radix, &c.
(17) **Senega.**
(18) **Chrysarobin.**
(19) **Ipecacuanha.**
(20) **Capsicum.**
(21) **Croton oil.**
(22) **Camphor.**
(23) **Cantharidin.**
(24) **Warmth,** however applied, but usually as a poultice.

Irritants.—All the above, as they dilate the vessels, are often spoken of as vascular irritants.

Rubefacients are drugs which, when locally

applied to the skin, cause it to become red because of the vascular dilatation induced. All the above drugs are rubefacients.

Vesicants.—Many of these drugs are sufficiently powerful irritants to cause inflammation. If this goes no further than the exudation of plasma from the vessels, and this plasma collects under the epidermis to form vesicles, the drug causing the production of vesicles is said to be a vesicant; *e.g.* cantharidin.

Pustulants are such of the above drugs as are sufficiently powerful irritants to cause the inflammatory process to proceed to the passage of leucocytes through the walls of the capillaries. They collect in the vesicles, which consequently become pustules; *e.g.* croton oil.

Escharotics or caustics are the most powerful of all the drugs acting on vessels. Their local application kills the part to which they are immediately applied, and sets up vascular dilatation of the surrounding area; *e.g.* strong nitric acid, zinc chloride, silver nitrate, and arsenious acid.

Counter-irritants.—It has been shown by experiments on animals that when the vessels of the skin are dilated by the application of an irritant, those of the viscera, especially those in the abdomen, are often reflexly constricted, leading to a rise of blood-pressure and slight acceleration of the heart and respiration. The same is probably true of man. An irritant is called a counter-irritant when it is applied to the skin with the object of constricting the vessels of the subjacent viscera. It is particularly to be remembered that this is a reflex nervous action, and is in no way due to the withdrawal of blood into the dilated vessels of the skin. Experience has shown that certain organs are best influenced by application of the counter-irritant to a definite part of the skin, *e.g.* a blister applied to the epigastrium relieves

gastric pain. Usually it will be found that the area of the skin is that which Head has shown to be associated with the viscus.

The following, when inhaled, dilate peripheral vessels by acting locally on them:

(1) **Amyl nitrite.**
(2) **Ethyl nitrite.**
(3) **Spiritus ætheris nitrosi.**

Drugs which, given some by mouth, others subcutaneously, dilate arterioles by acting locally on them:

(1) **Amyl nitrite.**
(2) **Trinitrin.**
(3) **Sodium nitrite.**
(4) **Ethyl nitrite.**
(5) **Spiritus ætheris nitrosi.**
(6) **Erythrol tetranitrate.**
(7) **Manitol hexanitrate.**
(8) **Belladonna.**
(9) **Hyoscyamus.**
(10) **Stramonium.**
(11) **Antimony.**

Drugs which, given some by mouth, others subcutaneously, contract arterioles by acting locally on them:

(1) **Ergot.**
(2) **Suprarenal extract.**
(3) **Extract of Posterior Part of Pituitary body.**
(4) **Digitalis.**
(5) **Squill.**
(6) **Convallaria.**
(7) **Apocynum.**
(8) **Physostigmine.**
(9) **Pilocarpine.**
(10) **Muscarine.**
(11) **Barium chloride.**

The pituitary extract, although causing general constriction of arterioles, dilates those of the kidney.

In addition to the above the following have been shown by experiments in the laboratory to cause contraction of small arteries through which they circulate:—

Salts of copper, zinc, tin, platinum, all cause powerful contraction.

Salts of lithium, calcium, strontium, magnesium, cadmium, nickel, cobalt, and iron cause slight contraction.

Drugs which, when locally applied to vessels, contract them.

These may act in two ways, either by contracting the muscular coat of the vessels, or by coagulating the albuminous fluids around them, the coagulum by its contraction constricting the vessels.

Those which, applied externally, contract the muscular coat of the vessels:

(1) **Cold,** however produced; hence rapidly volatilizing substances, as ether.
(2) **Suprarenal extract.**
(3) **Stypticin.**
(4) **Lead salts.**
(5) **Dilute solutions of Silver salts.**
(6) **Dilute sulphuric acid.**
(7) **Alum.**
(8) **Hamamelis.**
(9) **Acetanilide.**
(10) **Phenazonum.**

All the above, except the last two, are used in medicine to contract vessels.

Those which coagulate the albuminous fluids around the vessels:

(1) **Tannic acid and all** substances containing it; *e.g.* galls, krameria root, kino, hæmatoxylin, hamamelis, cinnamon, eucalyptus gum, and catechu.
(2) **Lead salts.**
(3) **Silver salts.**
(4) **Zinc salts.**
(5) **Copper salts.**
(6) **Alum.**
(7) **Per-salts of iron.**
(8) **Bismuth salts** to a slight extent.

B. Drugs which act on the Vaso-motor Centres.

Drugs which, by their action on the vaso-motor centres, dilate the vessels:

(1) **Alcohol.**
(2) **Ether.**
(3) **Chloroform.**
(4) **Chloral.**
(5) **Hydrocyanic acid.**
(6) **Opium.**
(7) **Thyroid gland.**

Some drugs, which in small doses contract vessels by central action, in large dilate them; *e.g.* digitalis and squill.

Drugs which, by their action on vaso-motor centres, cause contraction of vessels:

(1) **Ergot.**
(2) **Physostigmine.**
(3) **Hydrastis.**
(4) **Strychnine.**
(5) **Salicylic acid.**
(6) **Turpentine.**
(7) **Ammonia.**

C. Drugs acting on Vaso-motor Ganglia.—These are the same as act on the cardiac ganglia (*see* p. 58). After transitory stimulation they paralyse the ganglia, and hence blood pressure falls. Some think that the

rise of blood pressure caused by ergot is due to stimulation of these ganglia

Astringents are drugs which diminish the size of vessels, and so decrease exudation from them.

Styptics, or Hæmostatics, are drugs which stop bleeding. They comprehend all astringents, especially cold, adrenalin, lead and copper salts, hamamelis, ergot, tannic acid, and per-salts of iron, which coagulate the blood that is flowing from the vessel, and the clot prevents further bleeding. Matico leaves (B. P. 1885), because of the numerous hairs on their under surface, favour coagulation of blood when locally applied to a bleeding surface. Cobwebs act in the same way.

Therapeutics.—Drugs which locally dilate vessels are applied to stimulate sores to heal; they promote absorption of inflammatory products, including bacterial toxins which increase the resistance of the body to these toxins, as seen in the application of iodine over certain diseased joints; they act as counter-irritants in disease of deep-seated organs, as in the application of a blister for pleurisy. Drugs which by their central action cause dilatation of all the vessels of the body are used in certain forms of heart disease, as angina pectoris; and some suppose that the good they do is brought about by dilating the vessels and so rendering the work of the heart easier. Amyl nitrite and nitro-glycerin are much used for this purpose. Drugs causing general vascular dilatation are also employed to cause dilatation of the vessels of the skin, with the object of thereby leading to an increase of perspiration and an increased radiation of heat. Alcohol and Spiritus Ætheris Nitrosi amongst others are used in this way.

The most important use of astringents is as styptics; they are also used to check excessive discharges of all sorts, as in diarrhœa, leucorrhœa, &c.,

and in relaxed conditions of vessels, such as are often seen in pharyngitis.

There is perhaps no better opportunity than this of mentioning emollients and demulcents.

Emollients are substances which soften and protect parts. The word is usually employed for substances applied to the skin.

Common emollients are substances soaked in warm water, as hot fomentations and poultices; fats of various sorts, as lard and lanolin (hydrous wool fat); non-irritating oils, as olive oil, spermaceti, petroleum, vaseline, &c.

Demulcents are substances which protect and soothe parts. They retard the local action of substances dissolved in them, *e.g.* sugar tastes less sweet when dissolved in a demulcent than when dissolved in water. They are generally applied to mucous membranes, especially when unduly dry, and thus they are often used for the mouth.

Instances of them are gelatin, isinglass, glycerin, gum, honey, linseed, starch, spogel seeds, and white of egg.

Division V.—Drugs acting on the Skin.

All those described in the last section act on the cutaneous vessels, but in addition we have—

A. Diaphoretics, or drugs which increase the amount of perspiration. These may do so either by stimulating the sweat centres in the spinal cord, the nerves proceeding from the centres to the glands, the terminations of the nerves in the gland, or the glandular cells themselves; or dilatation of the cutaneous vessels may, by the increase in the amount of blood and the greater warmth, stimulate the glands and lead to an increase of sweat. It is difficult to tell whether drugs acting on the vessels do not also act on the other parts of the mechanism; and it is also difficult to decide whether a drug acts on the gland-cells or the terminations of the nerves, so we will consider

diaphoretics under two headings, those which act centrally and those which act peripherally. These are differentiated by observing whether the drug acts after the spinal cord is destroyed, and on a part of the skin after the nerves going to it are cut.

(*a*) *Diaphoretics acting peripherally:*

(1) **Pilocarpine.**
(2) **Muscarine.**
(3) **Nicotine.**
(4) **Antimony Salts.**
(5) **Ammonium acetate.**
(6) **Ammonium citrate.**
(7) **Warmth.**

(*b*) *Diaphoretics perhaps acting centrally:*

(1) **Ipecacuanha.**
(2) **Opium.**

(*c*) *Diaphoretics whose mode of action is doubtful:* **Colchicum, salicine, lobelia, aconite, potassium citrate and acetate.** All these are very feeble.

When a diaphoretic acts very powerfully it is called a **Sudorific**, *e.g.* pilocarpine.

B. Anhidrotics, or Antihidrotics, drugs which diminish the amount of perspiration. The part on which these act is determined in the same way as in the case of diaphoretics.

(*a*) *Anhidrotics acting peripherally:* **Atropine** is very powerful, acting on the ends of the nerves in the glands; **hyoscyamus, stramonium,** and **agaricin** act in the same way. The local application of cold has a similar action.

(*b*) *Anhidrotics the mode of action of which is doubtful* (these are reputed anhidrotics, but probably they have no effect):

(1) **Acids.**
(2) **Nux vomica.**
(3) **Quinine.**
(4) **Zinc salts.**

Therapeutics.—Diaphoretics are used for three purposes: either to increase the amount of sweat because that of the urine is failing, and for this purpose pilocarpine is largely used; or in the hope that poisons may be excreted by the sweat, hence the use of pilocarpine in uræmia; or as mild antipyretics, in order to increase the loss of heat by increased evaporation: for this purpose ipecacuanha,

ammonium acetate, and opium were formerly much employed, but of late years much more efficient antipyretics have been discovered.

Anhidrotics are used either for general conditions, as phthisis, or for local conditions, as sweating of the feet; but they are not of great use in medicine.

We do not know of any drugs which will alter the composition of the sweat, except in so far as that certain drugs may be excreted in the sweat when taken internally: such are iodine, potassium iodide, succinic, tartaric, and benzoic acids, the last in the form of hippuric acid.

We have no knowledge of the effects of drugs on the sebaceous secretion.

Certain drugs when taken internally in large doses produce a rash on the skin, possibly because in the course of their excretion through the skin they irritate it. Such are—

(1) **Copaiba.**
(2) **Cubebs.**
(3) **Bromides.**
(4) **Iodides.**
(5) **Turpentine.**
(6) **Belladonna.**
(7) **Chloral.**
(8) **Opium.**
(9) **Quinine.**
(10) **Salicylic acid.**
(11) **Arsenical salts.**
(12) **Acetanilide.**
(13) **Phenazonum.**
(14) **Phenacetin.**
(15) **Chloralamide.**
(16) **Antitoxins.**
(17) **Serums.**
(18) **Aconite.**
(19) **Silver** salts may discolour the skin.

Division VI.—Drugs acting on the Urinary System.

1. *Drugs increasing the quantity of urine secreted.* These are called diuretics. The kidney is a double organ with two distinct varieties of epithelium; it is particularly well supplied with vessels and vasomotor nerves, and is also profoundly under the influence of variations in the quantity of blood flowing through it; hence there are various ways in which diuretics may act, but the chief methods must

be either directly on the renal cells, or by increasing the flow of blood through the kidneys.

(*a*) *Diuretics acting on the renal cells:*

(1) **Caffeine.**
(2) **Theobromine.**
(3) **Scoparium.**
(4) **Buchu.**
(5) **Uva Ursi.**
(6) **Juniper.**
(7) **Turpentine.**
(8) **Mercury.**
(9) **Potassium acetate.**
(10) **Potassium citrate.**
(11) **Potassium carbonate.**
(12) **Potassium tartrate.**
(13) **Potassium acid tartrate.**
(14) **Corresponding sodium salts.**
(15) **Urea.**

(*b*) *Diuretics acting through the circulation:*

(1) **Digitalis.**
(2) **Squills.**
(3) **Stropanthus.**
(4) **Convallaria.**
(5) **Erythrophlœum.**
(6) **Apocynum.**
(7) **Pituitary extract.**
(8) **Alcohol.**
(9) **Cold to skin.**

Therapeutics.—Diuretics are used in cardiac and pulmonary diseases when, owing to the general vascular disturbance, the quantity of urine falls below the normal standard. Also in diseases in which there is excess of fluid in certain parts of the body; for example, pleuritic effusion and ascites, with the object of getting rid of as much fluid as possible by the kidneys. Also they may be used to dilute the urine, *e.g.* when it is prone to deposit its solids. Lastly, in certain forms of kidney disease, although in these maladies it is always a question how far it is desirable to stimulate diseased organs. It is of great importance to remember that diuretics may act in many different ways, that there are many causes for diminution in the quantity of urine secreted, and that it is difficult to say in any particular case what is the cause of the decrease in the quantity secreted. Therefore it is usual to give diuretics in combination, in the hope that if one of them does not have the desired result another will.

2. *Drugs diminishing the quantity of urine secreted.*—These are such as produce acute inflammation of the kidney when given in large doses; *e.g.* turpentine, cantharides, phosphorus. They are never given for this purpose in medicine.

3. *Drugs rendering the urine acid.*—The chief official drug that can do this effectually is hexamine which acts by the formation of formaldehyde in the urine. Benzoic acid in its passage through the kidney is converted into hippuric acid and is therefore a urinary antiseptic, but is inferior to hexamine. Either is given when from any cause the urine undergoes alkaline decomposition anywhere within the urinary passages. Acid sodium phosphate is the natural acid of the urine, and its administration by the mouth increases the acidity of that fluid. Salicylic acid will, to a slight extent, increase the acidity of the urine, as will very large doses of citric or tartaric acid.

4. *Drugs which render the urine alkaline.*—Those organic salts of the metals potassium, sodium, lithium, calcium which are oxidised in the body to carbonates and excreted as such by the kidneys, such as the tartrates and citrates, and to a less extent the acetates, will do this. The carbonates have the same effect. Nitric acid is said to increase the amount of ammonia in the urine, and thus to render it slightly alkaline. Organic ammonium salts and ammonium carbonate given internally do not render the urine alkaline, because they are decomposed in the body, urea being probably formed.

Lithontriptics are drugs which prevent the deposition in the urinary passages of the solids of the urine. If this fluid be acid, uric acid often crystallizes out, forming gravel or uric acid calculus; less often calcium oxalate crystallizes, giving rise to

calcium oxalate calculus. When there is any likelihood of the formation of either of these calculi, alkalies may be given. If the urine is undergoing alkaline decomposition phosphates are liable to crystallize out. In this case the object will be to render the urine acid and aseptic. This will be attained by giving hexamine, benzoic acid, the acid phosphates, and urinary antiseptics.

Therapeutics.—The chief use of alkalies is to diminish the acidity of the urine, so as to render the precipitation of uric acid unlikely; or to render it alkaline so as to attempt to dissolve uric acid crystals. We know of no drug which will dissolve those of oxalate of lime. Alkalies are also given to gouty subjects, partly to alkalize the blood, but also partly to alkalize the urine, for such persons are very prone to deposit uric acid in the urine. Potassium urate is much more soluble than sodium urate; citrates and acetates are not likely to upset the digestion, consequently the drugs most used are the citrates and acetates of potassium. Copious draughts of water, by diluting the urine, aid in preventing the deposition of uric acid or oxalate of lime calculi. Natural alkaline waters are largely used.

5. *Urinary Antiseptics.*—If the urine is retained in the bladder by stricture or from any other cause, it often undergoes alkaline decomposition as a result of bacterial infection, and the same result may be brought about by the admixture of pus with it. Bacteria may also exist in weakly acid urine. Sometimes they are excreted from the blood with the urine. The following drugs hinder the growth of bacteria in the urine, but the action of all but the first two is very feeble. Some act by rendering the urine acid (*see* p. 68). Hexamine by the rapid formation of formaldehyde provided the urine is

acid. So if this is alkaline, acid sodium phosphate is given as well as hexamine.

(1) Hexamine.	(6) Uva ursi.
(2) Benzoic acid.	(7) Many volatile oils.
(3) Acid Sodium Phosphate.	(8) Copaiba.
(4) Boric acid.	(9) Cubebs.
(5) Salicylic acid.	(10) Oil of sanders wood.

6. *Drugs altering the composition of the urine.*—Almost any drug will do this, either because it is excreted in the urine, or because it sets up some changes in the body the products of which are excreted in the urine; but here we shall only refer to certain striking examples.

Turpentine, cantharidin, and salicylic acid in large doses will cause blood to appear in the urine, because they set up inflammation of the kidney.

Potassium chlorate, all nitrites, acetanilide, pyrogallic acid, poisoning by the mushroom (*Helvella esculenta*), and transfusion of animals' blood, break up red blood-corpuscles, and the products are excreted in the urine, rendering it dark. Large doses of mineral acids, arsenic, and naphthol are said occasionally to produce the same result.

Phosphorus in large doses causes leucine and tyrosine to appear in the urine, and the ammonia is greatly increased.

The saline diuretics increase the solids of the urine.

Sulphonal and methylsulphonal may cause haematoporphyrin to appear in the urine.

The chrysophanic acid in rhubarb and senna makes the urine, if it is acid, a brownish colour; if it is alkaline, a purplish red. Logwood renders alkaline urine red or violet. Santonin colours acid urine yellow or greenish yellow, and alkaline urine red. Carbolic acid, naphthalene, creosote, and other preparations of tar, as well as the arbutin in uva ursi, make it dark greenish brown. Picric acid makes it a bright yellow, and methyl violet a dark blue.

The urine of persons poisoned with carbonic oxide remains sweet for months.

Poisoning by carbonic oxide, curare, amyl nitrite, fusel oil, and turpentine, and sometimes mercury, morphine, chloral, prussic acid, sulphuric acid, alcohol, acetanilide, phenacetin, lead compounds, and salicylic acid, leads to the

appearance in the urine of a body which like sugar reduces Fehling's copper solution. In most of these cases this body is not glucose, but glycuronic acid; for although it reduces blue copper solutions, it does not undergo alcoholic fermentation on the addition of yeast. The administration of phloridzin or phloretin leads to the production of genuine glucose in the urine, as does adrenalin by its action on the liver. The glycosuria produced by amyl nitrite is also probably of hepatic origin.

Other drugs cause a peculiar odour in the urine; for example, the smell of violets produced by turpentine. The aromatic odour of cubebs and copaiba can be detected in the urine after the administration of these bodies.

Lead, if taken for long periods, produces chronic interstitial inflammation of the kidney. It is stated that rarely mercury will do the same.

7. *Drugs acting on the bladder and urethra.*—The only ones of any practical value are sedatives to the urinary tract.

If the urine is decomposing, drugs preventing its decomposition fall under this head. Other sedatives are **belladonna, hyoscyamus, stramonium, pareira, buchu, uva ursi, couch grass, cissampelos,** and **hygrophila,** which are direct sedatives to the vesical and urethral mucous membrane. If the urine is excessively acid, alkalies are urinary sedatives.

Urinary sedatives are used very largely in cases of cystitis and urethritis, whatever the cause may be. Local astringent and antiseptic injections are also employed.

Division VII.—Drugs acting on the Bodily Heat.

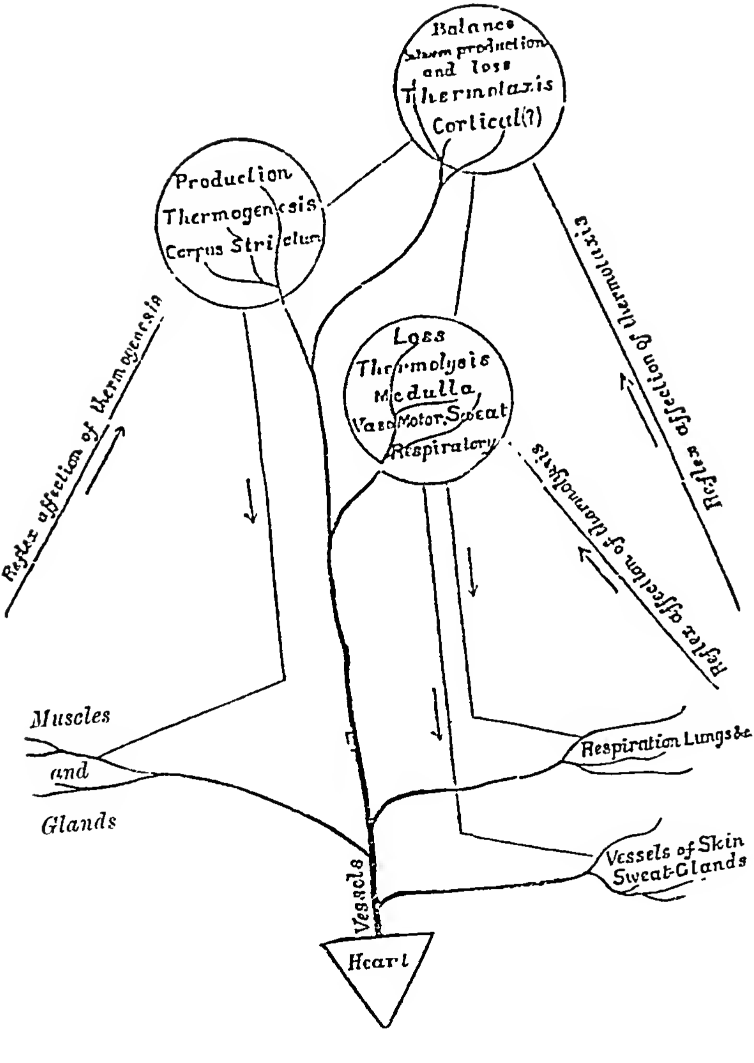
A. Antipyretics, or Drugs which decrease the Bodily Temperature.—There are few drugs which can markedly lower the temperature in health. Some, it is true, will cause the temperature to fall below normal if given to a healthy man in large enough doses to induce severe collapse. The word antipyretic is limited to those drugs which bring down the temperature when it is raised owing to disease.

We know that the greatest amount of heat is produced in the muscles and a considerable amount in the glands, a special part of the brain, the corpus striatum, presiding over this production; that heat is lost mostly by radiation from the vessels of the skin and by the evaporation of sweat, and that these vessels and the sudoriparous glands are under the control of the central nervous system. Heat is also lost through the lungs. As the production and loss are in health so accurately adjusted, many observers believe that there is a part of the cerebrum whose function it is to maintain the balance between the production and the loss. Also all parts of this complex mechanism are supplied with blood-vessels, and must be affected by the quantity and composition of the blood supplied to them.

It may also be that the part of the central nervous system which presides over the loss of heat (thermolysis), that which presides over the production of heat (thermogenesis), and that which possibly presides over the balance between the production and the loss (thermotaxis), can, each of them, be influenced by afferent impulses reaching them from various parts of the body, and thus we see each of these three functions can probably be reflexly affected. (*See* diagram on p. 73.)

Antipyretics which increase the loss of heat.—All sudorifics and all dilators of the cutaneous vessels act as antipyretics. Cold, such as a cold bath, increases the loss of heat by direct abstraction.

Antipypretics which probably diminish the production of heat.—Although it is probable that phenacetinum, phenazonum (antipyrin), and acetanilidum (antifebrin) diminish the production by their action on the corpus striatum, it is believed that they lower temperature chiefly by acting on the central thermotaxic mechanism so as to adjust the


Balance
of heat production
and loss
Thermotaxis
Cortical(?)
Production
Thermogenesis
Corpus Striatum
Loss
Thermolysis
Medulla
Vaso Motor, Sweat
Respiratory
Reflex affection of thermogenesis
Reflex affection of thermotaxis
Reflex affection of thermolysis
Muscles
and
Glands
Respiration Lungs &c.
Vessels of Skin
Sweat-Glands
Vessels
Heart

body temperature at a lower leval. Quinine, salicylic acid, and salicin also diminish the production; by directly diminishing metabolism. A cold bath not only abstracts heat, but, after it has been in operation some little time, diminishes the production.

Antimony, aconite, and digitalis are probably antipyretic through their effect on the circulation, but precisely how they and benzoic acid act is not known. Sometimes the removal of some irritation which may be acting reflexly lowers the temperature. In this way purgatives are occasionally antipyretics.

Therapeutics.—The use of antipyretics is to lower the temperature in fever.

Drugs which increase the loss of heat were formerly popular as antipyretics, especially alcohol, nitrous ether, antimony, ipecacuanha, and opium, but now they are not much used. Cold is more often employed, either by cold sponging, ice, or a cold bath. Sponging with hot water will, by the vascular dilatation and subsequent sweating it induces, reduce a febrile temperature.

Of the drugs which alter the production, acetanilide and phenazonum are dangerous because of the collapse they may produce; quinine and salicylic acid are rather uncertain, except in ague and rheumatic fever respectively. Phenazonum and phenacetinum are most in demand. They are certain antipyretics. Phenacetin is very safe, but less powerful. They are quickly absorbed, and so act promptly; they are far more powerful than any drugs which act by increasing the loss of heat, and these are very uncertain in their action, often not lowering the temperature at all. Another reason for preferring drugs which diminish thermogenesis or alter thermotaxis is that it is more rational to lower temperature by decreasing the production of heat than by increasing the loss, for then the production will, if

anything, go on faster, in consequence of the attempt to compensate for the increased loss. Antipyretics, however, should be rarely given, for probably fever is often beneficial.

B. Drugs which cause a rise of Temperature.—Belladonna, picrotoxin and cocaine in poisonous doses may do this, and β-tetrahydronaphthylamine may cause a rise of many degrees in a few hours. Probably all these increase heat production by action on the central nervous system.

Tuberculin, various albumoses, and certain animal poisons such as that of shell-fish will cause a rise of temperature. Their mode of action is unknown.

Division VIII.—Drugs acting on Respiration.

Respiration can be modified by such very various influences that it is difficult to decide upon the exact mode of action of any drug which affects it. For example, alterations in the blood and in the air will modify it; the respiratory centre itself may be influenced, either directly, or reflexly from almost any organ in the body; or, again, the movements of the respiratory muscles themselves may be interfered with; and, lastly, respiration is much under the influence of the circulatory apparatus. Furthermore, the chief object in medicine is to remove the cause of the respiratory difficulty rather than to act upon respiration itself.

We have already spoken of those drugs which produce changes in the blood and the circulation, and the consideration of those modifications of the

temperature, moisture, and pressure of the air which are of value in medicine belongs to a book on general therapeutics. We will therefore now consider the respiratory drugs under the following heads:

A. Drugs altering the Composition of the Air inhaled.—It is found convenient to administer some drugs, although they are not given for their influence on respiration, by making the patient inhale them; such are anæsthetics and amyl nitrite.

Some drugs when inhaled are particularly irritating to the bronchial mucous membrane, causing dilatation of the vessels, increased secretion, and reflexly cough from the stimulation of the sensory nerves of the bronchial mucous membrane.

Such are cold dry air, iodine, bromine, chlorine, senega, ipecacuanha, sulphurous anhydride, nitric acid fumes, ammonia, and tobacco. These are rarely used therapeutically as inhalations, and their inhalation is to be particularly avoided in irritable conditions of the bronchi.

The drugs which, when inhaled, are soothing to the bronchial mucous membrane are—

Hydrocyanic acid.	**Conium.**

These are rarely employed.

Inhalations which are used to stimulate the bronchi, that is to say, to increase their vascularity, secretion, and muscular power, are—

Carbolic acid, gr. 20.	**Tinctura Benzoini Composita**, fl. oz. ss.
Cajuput oil, ℳ20.	**Vapor Olei Pini Sylvestris** (B. P. 1885).
Creosote, fl. oz. ss.	
Cubebs oil, fl. oz. ss.	

The amounts given after each are the quantities that should be added to a pint of water at 55° C.

Inhalations which are used to disinfect foul secretions from the bronchial mucous membrane are those of—

(1) **Creosote.**
(2) **Iodoform.**
(3) **Mild solutions of benzoin.**
(4) **Carbolic acid.**
(5) **Sulphurous anhydride.**
(6) **Oil of juniper.**
(7) **Oil of cubebs.**

Inhalations for relieving spasm of the bronchial tubes are those of—

(1) **Conium.**
(2) **Stramonium.**
(3) **Chloroform.**
(4) **Ether.**
(5) **Amyl nitrite.**

B. Drugs acting directly on the Respiratory Centre.—If the drug, when injected into the carotid artery, very quickly produces its effect on respiration, it is concluded that it acts on the respiratory centre. Another experiment, often used to determine whether the drug acts on the centre, or on the vagal terminations in the lung, is to cut the vagi and to observe whether it acts similarly before and after the section.

Drugs which directly stimulate the respiratory centre are

(1) **Strychnine.**
(2) **Ammonia.**
(3) **Belladonna.**
(4) **Stramonium.**
(5) **Hyoscyamus.**
(6) **Caffeine.**

Drugs which depress the respiratory centre are—

(1) **Physostigmine** (very powerful).
(2) **Chloral.**
(3) **Chloroform.**
(4) **Ether.**
(5) **Alcohol.**
(6) **Opium.**
(7) **Hydrocyanic acid.**
(8) **Codeine.**
(9) **Diamorphine.**
(10) **Virginian Prune.**
(11) **Aconite.**
(12) **Veratrine.**
(13) **Nitrites.**
(14) **Gelsemium.**
(15) **Tobacco.**
(16) **Cocaine.**
(17) **Conium.**

Nitrites, Alcohol, Ether, and Chloroform slightly excite before they depress.

Therapeutics.—The drugs which excite the respiratory centre may be used when there is any difficulty in respiration, especially with the view of increasing the force of the respiratory act whilst other means are employed to get rid of the cause of the difficulty. They are, of course, most frequently required in diseases of the lungs, especially bronchitis. Ammonia is often employed, as it is also a powerful expectorant; and belladonna is useful when there is too much secretion from the bronchial tubes.

Substances which depress the respiratory centre are very little needed for this action; but the centre for the reflex act of coughing is in the close neighbourhood of the respiratory centre, and opium, hydrocyanic acid, codeine, diamorphine, Virginian prune, conium, and ipecacuanha are often very valuable in allaying the continual hacking cough which so frequently accompanies disease of the heart and lungs.

The drugs which relieve cough are very numerous, for it may be reflexly set up by irritation of so many peripheral parts, viz. nose, throat, pharynx, ear, teeth, larynx, trachea, bronchi, lungs, pleura, stomach and liver; and consequently its removal may depend upon the removal of peripheral irritation in any of these organs.

C. Drugs affecting the Bronchial Secretion.

(*a*) *Those increasing it:*

(1) **All alkalies, especially carbonate and other salts of ammonium.**
(2) **Ipecacuanha.**
(3) **Senega.**
(4) **Squills.**
(5) **Turpentine.**
(6) **Camphor.**
(7) **Benzoin.**
(8) **Balsam of Peru.**
(9) **Balsam of Tolu.**
(10) **Antimony salts.**
(11) **Iodine.**
(12) **Pilocarpine.**
(13) **Quillaia.**
(14) **Apomorphine.**
(15) **Terebene.**
(16) **Tar.**
(17) **Many volatile oils.**

(*b*) *Those decreasing it:*

(1) **Acids.**
(2) **Belladonna.**
(3) **Stramonium.**
(4) **Hyoscyamus.**

Many authorities think that under some circumstances alkalies decrease the secretion.

(*c*) *Those disinfecting it.*—Drugs which, when inhaled, act in this way have already been mentioned. Copaiba, cubebs, and many volatile oils are excreted partly by the bronchial mucous membrane, and thus will disinfect the secretion.

Therapeutics.—In bronchitis, remedies which increase the secretion are used when it is so viscid that it sticks to the tubes and cannot be coughed up; and those which decrease it are employed when it is too watery to be easily expectorated. The use of the disinfectants is obvious.

D. Drugs relaxing Spasm of the Muscular Coat of the Bronchial Tubes, or Antispasmodics.—The following relax contraction of the bronchial tubes:

(1) **Stramonium,**
(2) **Belladonna,**
(3) **Hyoscyamus,**
(4) **Grindelia,**
(5) **Lobelia,**
(6) **Adrenalin,**
(7) **Amyl Nitrite,**
(8) **Chloroform,**
(9) **Ether.**

The first three, and perhaps the next two, paralyse the terminations of the vagus in, and the last four act directly on, the bronchial muscles. It is likely, judging by their analogous action in other parts of the body, that the following drugs also relax bronchial spasm:

Opium, Chloral, Cannabis Indica, and Conium.

Therapeutics.—Several of these are of great use in asthma, and may be employed for cases of bronchitis in which it is probable that the irritation caused by the inflammation of the tubes sets up spasm of them.

E. Drugs causing spasm of the muscular coat of the bronchial tubes—

Muscarine, Pilocarpine, and Physostigmine excite the vagal endings and induce typical bronchiolar constriction,

which is abolished by Atropine. Barium, Veratrine, Bromine, and the salts of many of the heavy metals (*e.g.* Gold) produce constriction which is not influenced by Atropine.

F. Drugs acting on the Vessels of the Bronchi.—These are the same as have been already described (p. 58) as acting on the vascular system generally, but adrenalin, pilocarpine, and muscarine, although they constrict vessels generally, dilate those of the lungs.

G. Expectorants.—The modes of action of drugs acting on the respiratory system are so complex that it is usual to regard most of them clinically simply as drugs which hinder or aid the expectoration of the contents of the bronchial tubes. Those which aid it are divided into two groups, named after their action, not on the lungs, but on the circulation.

1. *Stimulating expectorants.*—These are stimulants to the circulation generally. They are—

(1) **Acids.**
(2) **Ammonium salts.**
(3) **Senega.**
(4) **Squills.**
(5) **Benzoin.**
(6) **Benzoic acid.**
(7) **Balsam of Tolu.**
(8) **Balsam of Peru.**
(9) **Turpentine** preparations.
(10) **Terebene.**
(11) **Oleum Abietis.**
(12) **Nux vomica.**
(13) **Sulphur.**

2. *Depressing expectorants.*—These depress the general circulation. They are—

(1) **Alkalies.**
(2) **Antimony salts.**
(3) **Ipecacuanha.**
(4) **Lobelia.**
(5) **Pilocarpine.**
(6) **Apomorphine.**
(7) **Saponin.**
(8) **Potassium iodide** (very slightly depressant).

Therapeutics.—It is almost impossible to lay down any general directions. The prescriber must consider in any case before him whether he wishes to stimulate or to depress the circulation, to increase or to diminish or to disinfect the expectoration, to stimulate the respiratory centre, to overcome spasm

of the bronchial tubes, or to allay a hacking cough; and he must combine his remedies according to the answer he makes to these questions. Warmth to the chest and warm drinks are sedative, and increase the amount of secretion. Cold and cold drinks have an opposite effect.

H. Drugs which in Man sometimes produce Cheyne Stokes breathing—

These are morphine, potassium bromide, and chloral hydrate. In animals the following in addition may do it: picrotoxin, muscarin, digitalin, strychnine, and ammonium carbonate.

Division IX.—Drugs acting on the Digestive Apparatus.

A. Drugs acting on the Teeth.—Soaps and powders are used for cleaning the teeth. The basis of most tooth powders is chalk, which acts mechanically; charcoal is sometimes used in the same way. As the food is very liable to collect and decompose between the teeth, antiseptics, as quinine, borax, and carbolic acid, are often mixed with tooth powders. Astringents, such as rhatany and areca nut, are employed if the gums are too vascular. Mineral acids and alum are injurious to the teeth if used for a long time, and iron is liable to stain them; therefore these substances are best taken through a quill, and should not be used as gargles for long together.

Toothache may be relieved by local anodynes, as creosote, or strong carbolic acid. The tooth is plugged with cotton wool soaked in one of these. Clean cotton wool is placed over the carbolized wool to prevent the acid from reaching the mouth. This method may damage the tooth pulp.

B. Drugs acting on the Salivary Glands.—Much attention has been devoted to the submaxillary gland of the dog, and there is no reason for supposing that the other salivary glands of that animal or of other creatures differ markedly from it. We know that the submaxillary gland is under the influence of the chorda tympani nerve, which contains vaso-dilator fibres, and also some which directly modify the secretion of the gland apart from the secondary effects, due to the alterations in the vessels, obtained when the chorda tympani is stimulated. This nerve has its centre in the medulla, and is capable of being excited reflexly by stimulation of many nerves, even the sciatic, but especially by stimulation of the gastric branches of the vagus, and by the terminations in the tongue and mouth of the glosso-pharyngeal and gustatory nerves. The gland is also supplied with sympathetic branches which proceed from the cervical sympathetic trunk; these are vaso-constrictor, but the secretion is also increased by their stimulation. Drugs which increase the amount of saliva have been called sialogogues; those which decrease it, antisialogogues. It is clear that there are very many ways in which each of these might act, but here it will suffice to enumerate only those ways in which they are known to act.

1. *Sialogogues acting directly on the gland.*—Of these pilocarpine has been most studied. It acts equally well after section of all the nerves going to the gland. It acts when it is injected directly into the gland but is prevented from reaching the general circulation, and therefore might act on secretory cells or nerve endings; but it does not act on the cells—for if atropine which paralyses the junction between the cells and nerves is given, injection of pilocarpine produces no secretion—nor on nerve endings, for it

causes secretion if the chorda tympani is degenerate: therefore it acts on some substance forming a junction between cells and the nerve endings.

Sialogogues falling under this heading are—

(1) **Pilocarpine,**	(4) **Mercury,**
(2) **Muscarine,**	(5) **Physostigmine,**
(3) **Compounds of Iodine,**	(6) **Nicotine.**

The last acts on the ganglionic cells.

2. *Sialogogues acting reflexly by stimulating the peripheral ends of afferent nerves.*—Of these there are two important varieties:

(*a*) Those stimulating the gustatory and glosso-pharyngeal nerves in the mouth:

(1) **All Acids** and	(5) **Ether.**
(2) **Acid Salts.**	(6) **All pungent substances,** as mustard and ginger.
(3) **Chloroform.**	
(4) **Alcohol.**	

(*b*) Those stimulating the vagus in the stomach:

Most emetics, especially **Antimony** and **Ipecacuanha.**

4. *Antisialogogues acting either on the secreting cells or the terminations of the nerves in them.*—Of these atropine has been most studied, and it is proved to act directly on the gland by the fact that the administration of it prevents any increase of salivary secretion on stimulation of the chorda by electrodes applied at any part of the nerve, or thrust into the gland so that they could only act on the terminations of the nerve or the cells which atropine does not affect, for after it stimulation of the sympathetic still produces secretion. But the vaso-dilator fibres of the chorda are not paralysed by atropine, from which it is concluded that the junctions between the ends of the chorda and the cells are paralysed by it.

Antisialogogues falling under this heading are—

(1) **Belladonna,**
(2) **Hyoscyamus,**
(3) **Stramonium.**

5. *Antisialogogues acting reflexly by depressing the peripheral ends of afferent nerves.*—Alkalies, opium, and any substances which allay irritation of the mouth. Part of the effect of opium is due to its depressing action on the medullary centre.

Therapeutics.—A deficiency in the amount of saliva secreted is seen most markedly in fever, when the mouth becomes very dry, and the patient complains of thirst. Sometimes it is a disease in itself, and the origin of this malady is then probably nervous. It is a prominent symptom of belladonna poisoning. In fever, acid drinks, especially those containing carbonic acid gas or lemonade, are of use as sialogogues. Drinks which relieve this febrile thirst are called **Refrigerants.** For the disease known as "dry mouth" pilocarpine has been used, and it will relieve the dryness due to belladonna poisoning. Excessive salivary secretion is hardly met with except as a symptom of poisoning, especially by mercury and pilocarpine. In some forms of indigestion the saliva has a very unpleasant taste, and may even be diminished in quantity, but then the indication is to treat the indigestion.

C. **Drugs acting on the Stomach.**—Strictly speaking, we ought to consider these under the following heads:—Those which, by modifying the secretion of hydrochloric acid or pepsin, influence the conversion of proteins into peptones and albumoses. Those which influence the property possessed by the gastric juice of curdling milk. Those which affect its antiseptic power by modifying the secretion of acid. Those which modify the secretion of mucus. Those which influence the nerves, the vessels, or the move-

ments of the stomach. Lastly, those which are emetics. Our knowledge, however, is not sufficient to enable us to do this, and the most useful classification is into those affecting the secretion of gastric juice as a whole, the secreted contents, the vessels, the nerves, the movements, and emetics.

1. *Drugs increasing the activity of gastric juice secreted.*—These are usually called stomachics, and include a great many substances. Pawlow's researches show that the most powerful excitant of the flow of gastric juice is appetite, hence the sight of food which excites appetite excites gastric flow; food which is not appetising and the mere mechanical stimulation of the mouth or stomach do not do so. Many drugs, *e.g.* bitters and aromatics, increase the gastric flow because they act on the gustatory nerves in the mouth, increasing the appetite.

The drugs which increase the flow of gastric juice are—

(1) **Aromatics.**
(2) **Bitters.**
(3) **Pungent substances** (pepper, mustard, horseradish).
(4) **Meat extracts.**
(5) **Alcohol.**
(6) **Ether.**
(7) **Chloroform.**
(8) **Water.**

Therapeutics.—Stomachics are very largely used for the purpose of increasing the secretion of gastric juice in cases of dyspepsia.

2. *Drugs decreasing the activity of gastric juice secreted.*

(1) **Alkalies.** (2) **Fats.** (3) Many of those in the last list if given in large doses, *e.g.* alcohol, ether, chloroform.

Therapeutics.—Alkalies, especially sodium bicarbonate, are frequently given when there is a hyper-secretion of gastric juice. They neutralize this and render the hyper-secretion of mucus less tenacious.

Fats, *e.g.* olive oil, are given to lessen the secretion of acid in cases of gastric or duodenal ulcer.

3. *Drugs altering the composition of the gastric contents.*—Acids and alkalies naturally modify the reaction of the gastric contents. For this purpose dilute mineral acids are often prescribed to be taken about two hours after a meal, in cases in which the cause of indigestion is thought to be that the amount of hydrochloric acid secreted is deficient. In cases of indigestion in which, from the nature of the vomited matters or from any other reason, it is considered that there is an excess of acid in the stomach, alkalies are given at or after meal-times, the favourite drug being sodium bicarbonate.

Pepsin is given, usually in combination with dilute hydrochloric acid, when it is probable that the cause of the indigestion is the secretion of too small an amount of pepsin; but in this, as in every other variety of dyspepsia, it is far more important to remove the cause of the indigestion than to endeavour to modify the composition of the secreted gastric juice.

Many attempts have been made to try by the administration of antiseptics to prevent fermentation and putrefaction from going on in the stomach, but with a limited success, for a sufficient dose is frequently deleterious. Here even more than in the last case the right treatment is to remove the cause of the fermentation or putrefaction.

Drugs that have been used for this purpose are—

(1) **Cyllin.**
(2) **Carbolic acid.**
(3) **Iodoform.**
(4) **Boric acid.**
(5) **Creosote.**
(6) **Eucalyptus.**
(7) **Thymol.**
(8) **Sodium hyposulphite.**
(9) **Sulphurous acid.**
(10) **Naphthol.**
(11) **Bismuth Salicylate.**
(12) **Salol.**

4. *Drugs which dilate the vessels of the stomach.*—The vessels of the stomach are very sensitive to irritation. They easily dilate upon mechanical irritation, and the presence of food, especially peptones, causes the vascularity of the mucous membrane to increase. Within limits greater vascularity is an advantage, for it not only favours the secretion of gastric juice, but it facilitates absorption.

The substances which increase the vascularity of the stomach are all stomachics, dilute mineral acids, the drugs which have already been enumerated as irritants generally, and squill, digitalis, colchicum, senega, copaiba, cambogia, guaiacum, and veratrine. This is a very long list, and many of the substances in it are never employed for their irritant effect; in fact, the only ones in common use are the stomachics: the others are far too powerful; even small doses of them set up inflammation of the gastric wall, which is also produced by over-indulgence in stomachics, as we constantly see in the gastritis induced by alcohol. The therapeutic indications for this class of drugs are the same as those for stomachics generally.

Gastro-intestinal irritants.—In describing the individual actions of drugs the statement is frequently made that they are gastro-intestinal irritants, and this is a convenient opportunity for describing the symptoms produced in health by these drugs. If the drug has a caustic action, as many gastro-intestinal irritants have, the swallowing of it will cause considerable pain in the mouth and pharynx; in a short time these parts will become severely inflamed, and consequently very much reddened, swollen, and painful. The tongue will be often much enlarged. If the drug is corrosive, sloughs, generally white in colour at first, with a severely inflamed area around them, will be seen; as they fall off they will leave ulcers. Owing to the pain and swelling, it will for

some time be impossible to take any food, or at the best only that of a soft or fluid nature. Directly the drug reaches the stomach intense irritation is set up, consequently the patient feels severe abdominal pain, and generally there is soon violent retching and vomiting. As the poison passes on it produces its severe irritant effects on the intestine, and diarrhœa sets in. Both the vomited matters and the motions often contain blood. The general symptoms are an anxious countenance, small feeble pulse, scanty urine, a low temperature, and all the symptoms of collapse. Later on the gastro-intestinal irritation may be severe enough to set up general peritonitis, or a gastric ulcer may form, and then there may be added to the case all the symptoms of gastric ulcer and its sequelæ. The inflammation of the œsophagus may lead to its contraction. At the post-mortem examination, if the patient has died soon after the administration of the poison, the stomach will be very red and ecchymosed, with a swollen mucous membrane. Parts of the intestine will be in the same condition. This severe inflammation may, in many places, have led to the formation of sloughs. It must be remembered that many gastro-intestinal irritants have no action on the mouth. Nicotine is a gastro-intestinal irritant because of its action on the ganglia of the intestinal nerves leading to increased peristalsis and secretion.

5. *Drugs which contract the gastric vessels.*—These are the same as those which have already been enumerated as being generally astringent. They are much more used for the intestine than the stomach, and will therefore be considered in detail presently (p. 99).

6. *Drugs acting on the nerves of the stomach.*—All drugs powerfully irritant to the stomach cause pain in it; those that are only slightly irritant give rise to a sensation of warmth. It is never desired to produce gastric pain.

Gastric sedatives.—These drugs are the same as those which are local sedatives to other parts of the body. Those most used for the stomach are

(1) **Bismuth carbonate.**
(2) **Bismuth subnitrate.**
(3) **Bismuth salicylate.**
(4) **Opium.**
(5) **Hydrocyanic acid.**
(6) **Carbonic acid.**
(7) **Ice.**
(8) **Belladonna.**
(9) **Hyoscyamus.**
(10) **Stramonium.**

They are employed in the very many painful forms of dyspepsia. All, except perhaps stramonium, are in frequent use.

7. *Drugs acting on the movements of the stomach.* It has been observed that the movements of the stomach increase as the acidity of the contents increases. If it be that the acidity is the cause of the movements, anything which causes an increase of acidity will lead to more powerful movements. Apart from this, strychnine appears directly to stimulate the plain muscle of the gastric wall. Stomachics also probably aid the movements, so that our complete list will be mineral acids, nux vomica, and stomachics.

The proper churning up of the gastric contents is so necessary, that the value in dyspepsia of drugs which aid the gastric movements is very great. Hence the frequency with which nux vomica enters into antidyspeptic acid mixtures.

Carminatives.—This term is often applied to substances which aid the expulsion of gas from the stomach and intestines. They act either by stimulating the gastric and intestinal movements or by so regulating muscular contraction as to diminish spasm. It has been found from clinical observation that the most efficient carminatives are—

(1) **Stomachics** generally, especially—
(2) **Aromatics,**
(3) **Bitters,**
(4) **Pungent substances,**
(5) **Alkalies,**
(6) **Asafetida,**
(7) **Ammoniacum,**
(8) **Valerian,**
(9) **Camphor, and**
(10) **Volatile Oils.**

8. *Emetics.*—It is well known that the many complicated mechanisms involved in the act of vomiting are under the control of a centre in the medulla, which is capable of being stimulated by afferent impulses reaching it from many sources, such as the cerebrum, as when sights or smells cause sickness, the mouth, the pharynx, the œsophagus, the lungs, the heart, the stomach, the intestines, the biliary passages, the kidney, the peritoneum, and the uterus; so that drugs acting on any of these organs, or on the centre itself, might be emetics. But it is usual, in describing drugs which cause vomiting, to mention only those which do so either by acting on the stomach or on the centre in the medulla, and they are divided into two corresponding classes. Those acting on the stomach are sometimes called direct emetics, because they act directly on the stomach; and those influencing the medulla are called indirect; but some authors reserve the word direct for those acting on the medulla, and speak of those affecting the stomach as indirect. Considering this confusion, it is better to divide emetics into gastric and central. By means of the following experiments we determine to which group any drug belongs.

(1) The emetic is injected directly into the circulation. If very shortly after this vomiting takes place, the drug must have acted on the medulla, to which it has been carried by the circulation; but if some time elapses we conclude it acted on the stomach, and that it was first excreted into this organ before vomiting took place. This experiment may be made still more striking by injecting directly into the carotid, for then the medulla is quickly reached.

(2) If the least quantity of the drug which, when injected into the circulation, will produce vomiting is larger than is necessary when it is introduced directly into the stomach, the inference is that the

drug acts primarily on the stomach, and that when it produces vomiting after injection into the circulation it only does so because some of it has been excreted into the stomach.

(3) If the drug will not produce vomiting after injection into the circulation when the stomach is replaced by a bladder, it shows that it acted on the stomach; but if vomiting is produced it shows that the drug acted on the medulla, and that the vomiting is caused by the contraction of the abdominal muscles.

(4) If the drug takes a long while to act after its introduction into the stomach, it probably acts centrally; and the reason for the delay is that sufficient time must elapse for the drug to be absorbed.

In spite of these experiments it is difficult to be sure about the action of emetics, for some act in both ways, and some may in the course of their circulation through the blood act upon some of the many parts of the body from which the vomiting centre receives afferent impulses.

The following is a list of those emetics which are commonly used.

(1) **Apomorphine.**
(2) **Tartar emetic.**
(3) **Ipecacuanha.**
(4) **Alum.**
(5) **Ammonium carbonate.**
(6) **Copper sulphate.**
(7) **Zinc sulphate.**
(8) **Sodium chloride.**
(9) **Mustard.**
(10) **Warm water.**

Of these apomorphine is the only one that acts solely centrally. The others all act chiefly on the stomach, but tartar emetic and ipecacuanha probably act partly centrally.

Therapeutics.—Emetics have two uses. Firstly, to remove the contents of the stomach. Thus when that organ is over-full, and there is a feeling of nausea, an emetic by emptying the stomach may relieve. Emetics are largely used to empty the stomach in cases of poisoning, and they may benefit certain

cases of sick headache. An emetic occasionally aids the expulsion of a foreign body which has become impacted in the fauces or œsophagus. Secondly, emetics are used to expel the contents of the air-passages, especially in children, for they cannot expectorate well. For this purpose these drugs are given to help children to expel the morbid products in bronchitis, laryngitis, and diphtheria. They also aid the expulsion of foreign bodies that have become impacted in the larynx. In choosing an emetic it will be remembered that although apomorphine, ipecacuanha, and tartar emetic are the most powerful they are the most depressant, and are therefore not suitable in many cases—such, for instance, as poisoning accompanied by severe collapse. When the poison is a powerful gastro-intestinal irritant, if the condition of the mouth and œsophagus will allow of it, it is preferable to wash out the stomach rather than to use an emetic.

Emetics are not permissible for patients suffering from aneurysm, hernia, prolapse of the uterus or rectum, peritonitis, or a tendency to hæmorrhage, because of the straining induced by the vomiting, which should make us cautious in giving them to those who have disease of their vessels or high tension in them, for the straining may lead to hæmorrhage.

9. *Antiemetics.*—The causes of vomiting are so numerous that the number of drugs which may stop vomiting is very large; therefore, as in the case of emetics, we can only consider those which act either on the stomach or on the centre in the medulla.

Antiemeties acting on the stomach.—These are all those substances which have been already enumerated as having a sedative influence on the gastric nerves, viz.:

(1) **Ice**, (2) **Bismuth carbonate**, (3) **Bismuth subnitrate**, (4) **Opium**, (5) **Hydrocyanic acid**, (6) **Carbonic acid.** Also some drugs which occasionally appear to

have a specific local action in arresting vomiting; such are (7) **Cocaine**, (8) minute doses (1♏) of **Vinum Ipecacuanhæ**, (9) minute doses (1♏) of weak **Tincture of Iodine**, (10) minute doses of **Arsenious acid**, (11) small doses of each of **Alcohol**, (12) **Carbolic acid**, (13) **Chloroform**, (14) **Creosote**, (15) **Ether**, (16) and **Silver nitrate**.

Antiemetics acting centrally—

(1) **Opium**. (2) **Bromides of Ammonium**, (3) **of Potassium**, and (4) **of Sodium**. (5) **Chloral hydrate**. (6) **Amyl nitrite**. (7) **Nitroglycerin**. (8) **Dilute Hydrocyanic acid**. (9) **Alcohol**. It will be noticed that some drugs fall under both headings.

Therapeutics.—The very name of these drugs indicates their therapeutical application. At the best they are only palliative; the right way to treat vomiting is, if possible, to remove the cause. Of antiemetics, ice, dilute hydrocyanic acid, carbonic acid, bismuth salts, morphine, and iodine are perhaps the most reliable, but all are very uncertain.

D. Drugs acting on the Intestines.—Many secretions are poured into the intestine, the food is much altered by the time it arrives there, and it is changed in its course down the intestine; the physiology of intestinal digestion, of the movements and the nervous mechanisms of the intestine are imperfectly known; drugs may be considerably altered by the time they come to this part of the alimentary canal, and its diseases are little understood; consequently we cannot arrange the action of drugs in a physiological classification. We know, in fact, of only two important divisions, purgatives and astringents.

The methods of experiment which have been used to determine the mode of action of purgatives are chiefly those of Thiry and Moreau. The first-named observer cut the intestine across in two places a short distance apart: the isolated part which was still attached to the mesentery was sewn up at one end;

cases of sick headache. An emetic occasionally aids the expulsion of a foreign body which has become impacted in the fauces or œsophagus. Secondly, emetics are used to expel the contents of the air-passages, especially in children, for they cannot expectorate well. For this purpose these drugs are given to help children to expel the morbid products in bronchitis, laryngitis, and diphtheria. They also aid the expulsion of foreign bodies that have become impacted in the larynx. In choosing an emetic it will be remembered that although apomorphine, ipecacuanha, and tartar emetic are the most powerful they are the most depressant, and are therefore not suitable in many cases—such, for instance, as poisoning accompanied by severe collapse. When the poison is a powerful gastro-intestinal irritant, if the condition of the mouth and œsophagus will allow of it, it is preferable to wash out the stomach rather than to use an emetic.

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Antiemetics acting centrally—

(1) **Opium**. (2) **Bromides of Ammonium**, (3) of **Potassium**, and (4) of **Sodium**. (5) **Chloral hydrate**. (6) **Amyl nitrite**. (7) **Nitroglycerin**. (8) **Dilute Hydrocyanic acid**. (9) **Alcohol**. It will be noticed that some drugs fall under both headings.

Therapeutics.—The very name of these drugs indicates their therapeutical application. At the best they are only palliative; the right way to treat vomiting is, if possible, to remove the cause. Of antiemetics, ice, dilute hydrocyanic acid, carbonic acid, bismuth salts, morphine, and iodine are perhaps the most reliable, but all are very uncertain.

D. Drugs acting on the Intestines.—Many secretions are poured into the intestine, the food is much altered by the time it arrives there, and it is changed in its course down the intestine; the physiology of intestinal digestion, of the movements and the nervous mechanisms of the intestine are imperfectly known; drugs may be considerably altered by the time they come to this part of the alimentary canal, and its diseases are little understood; consequently we cannot arrange the action of drugs in a physiological classification. We know, in fact, of only two important divisions, purgatives and astringents.

The methods of experiment which have been used to determine the mode of action of purgatives are chiefly those of Thiry and Moreau. The first-named observer cut the intestine across in two places a short distance apart: the isolated part which was still attached to the mesentery was sewn up at one end;

the other, the open end, was attached to the abdominal wall, and thus there was a test-tube-like piece of intestine into which drugs could be placed. The parts of gut either side of the excised piece were sewn together, so that the whole intestine was the same as before but a little shorter. This method did not give very satisfactory results, and consequently Moreau devised his experiments, which seem more trustworthy. He put four ligatures round the intestine at equal distances apart, so that he shut off from the rest of the gut and from each other three pieces of intestine, each the same length. With a fine syringe he injected into the middle piece the drug to be experimented upon, and returned the whole into the abdominal cavity. In a few hours the animal was killed, and the state of the interior of the middle piece was contrasted with that of the pieces either side of it. Before Moreau's experiments there had been much discussion as to whether some purgatives did not act only by increasing the action of the muscular coat, and others only by stimulating the secretions, but from these experiments it appears that the majority act in both ways, some very slightly on the secretion and powerfully on the muscle and others less on the muscle and more on the secretion. But probably when purgatives are given in medicinal doses much of the fluid expelled is merely natural intestinal fluid which has been hurried through the intestine before it could be reabsorbed, and with all purgatives the increased muscular contraction which is a local effect is the chief action. It is undecided whether purgatives can cause increased muscular contraction in parts of the bowel with which they do not come in contact; the emptying of the colon which may follow after small rectal enemata appears to show they can, but then the drug may be absorbed from the rectum and excreted into the colon. Many purgatives (*e.g.* aloin, pituitary extract) act when given subcutaneously;

such action is due to local action on the bowel. In many vegetable purgatives the purgative principle is a glucoside. All these purgative glucosides readily yield derivatives of anthraquinone, and it is to these derivatives that purgation is due, *e.g.* they are contained in rhubarb, purgatin, phenolphthalein, senna, cascara, aloes (see p. 96). We will first consider intestinal purgatives, and then intestinal astringents.

Purgatives are divided into the following classes.

Laxatives.—These are substances which slightly increase the action of the bowels chiefly by stimulating their muscular coat.

They are—

(1) **Whole meal bread.**
(2) **Honey.**
(3) **Treacle.**
(4) **Most fruits,** especially—
(5) **Tamarinds,**
(6) **Figs,**
(7) **Prunes,** and
(8) **Stewed apples.**
(9) **Manna.**
(10) **Cassia.**
(11) **Sulphur.**
(12) **Magnesia.**
(13) **Olive oil.**
(14) **Castor oil** (small doses).
(15) **Vaseline.**
(16) **Liquid Paraffin.**

These are all of them domestic remedies employed for slight cases of constipation, especially in children; some, as brown bread, fruits, honey, form articles of diet with persons who are liable to constipation. (17) ergot, (18) nux vomica, (19) belladonna, (20) hyoscyamus, and (21) stramonium are also laxatives, but are not used except under medical orders. Nux vomica is most valuable; it is probably a direct stimulant to the muscular coat, hardly influencing secretion. It is largely used in cases of chronic constipation, especially when occurring in anæmic persons, or in those in whom, for any reason, it is likely that the intestinal peristalsis is feeble.

Belladonna in small doses increases peristaltic

movements because it paralyses the inhibitory fibres of the splanchnics, but in moderate doses it completely arrests peristaltic movements. It is chiefly employed for this latter purpose, especially in combination with opium. Hyoscyamus acts on the intestines in the same way, and small doses of it are often given with other purgatives to prevent griping, for it gives an orderly rhythm to the irregular contractions the stronger purgatives produce.

Ergot is hardly ever used for its laxative effect.

Simple purgatives.—These are rather more powerful in their action than laxatives. They stimulate peristalsis and also increase secretion. Some of the laxatives, as castor oil and magnesia, when given in large doses become simple purgatives.

The simple purgatives are—

(1) **Aloes.**
(2) **Rhubarb.**
(3) **Cascara Sagrada.**
(4) **Senna.**
(5) **Purgatin.**
(6) **Phenolphthalein.**
(7) **Fel Bovinum.**
(8) **Pituitary Extract.**
(9) **Physostigmine.**

It is interesting to observe that the first four all contain and owe their activity to emodin (trioxymethylanthraquinone), rhubarb and senna contain chrysophanic acid (dioxymethylanthraquinone). Purgatin is an anthraquinone derivative, and phenolphthalein has a somewhat similar structure. Hence these drugs are sometimes called anthracene purgatives, for anthraquinone is anthracene in which CO is substituted for one of the CH groups. The indications for each will be given under the individual drug. Pituitary extract and physostigmine act almost entirely on the muscular coat.

Drastic purgatives, often called cathartics.—These excite greatly increased secretion and peristaltic movements, and if given in large doses cause severe irritation of the intestine with much secretion

of mucus, great vascular dilatation and even hæmorrhage, severe abdominal pain and collapse, with profuse diarrhœa. The peristaltic contractions are often irregular, and hence there may be much griping pain; therefore it is usual to prescribe hyoscyamus with these drugs, which are in order of efficiency—

(1) **Calomel.**
(2) **Podophyllum.**
(3) **Aloes.**
(4) **Jalap.**
(5) **Scammony.**
(6) **Ipomœa.**
(7) **Oleum Terebinthinæ.**
(8) **Colocynth.**
(9) **Croton oil.**
(10) **Kaladana.**
(11) **Turpeth.**

Some, as jalap, are often called **hydragogue**, because of the large amount of secretion they excite.

Therapeutics.—Drastic purgatives are employed in obstinate constipation, and also to produce very watery evacuations with the object of removing as much fluid from the body as possible. Hence the frequent use of jalap in Bright's disease.

Saline purgatives.—These in hypertonic solution increase the passage of fluid from the tissues into the intestine, and if in hypotonic or isotonic solution prevent absorption of fluid, as they all pass slowly through the intestinal walls, so in both cases a large amount lies in the intestine. The distension due to this excites gentle peristalsis, and consequently an easy painless evacuation of the bowels. Osmosis certainly plays some part in the process, but it cannot be entirely explained by physical laws, because of the selective action of the intestinal epithelium for particular ions; thus sodium sulphate is very slowly passed through the intestinal wall, but sodium chloride, which is therefore not a purge, goes through quickly. The action is entirely local, for no purgation follows if the salts are

injected into the blood, but Hurst and his co-workers believe the salts are absorbed and act, through the vessels, directly on the colon as stimulants to movement and secretion, for they find that none of the salt taken reaches the colon by the intestinal canal until long after the evacuation produced by the salt. The saline purgatives are—

(1) **Potassium tartrate.**
(2) **Potassium acid tartrate.**
(3) **Potassium sulphate.**
(4) **Sodium sulphate.**
(5) **Sodium tartrate.**
(6) **Sodium citro-tartrate.**
(7) **Sodium phosphate.**
(8) **Sulphate and other salts of magnesium.**

Therapeutics.—These are very largely used as habitual purgatives, especially for persons suffering from any form of gout. They form the essential ingredient of most purgative mineral waters, as Hunyadi János, Pullna, Friedrichshall, Æsculap and Rubinat.

The best way of taking them is to put the required dose of the salt or the mineral water in a tumbler, add some lukewarm water, and sip it slowly while dressing in the morning.

For cholagogue purgatives see p. 100.

Enemata.—Any fluid preparation injected into the rectum is called an enema. When a purgative is liable to produce sickness, or it is unadvisable, because of peritonitis, intestinal obstruction, ulceration, or other disease, to give it by the mouth, it may be given by the rectum. Castor oil, aloes, olive oil, magnesium sulphate, and soap may be administered in this way. Enough of a vehicle should usually be given to make a purgative enema up to three quarters of a pint or a pint, for distension of the rectum greatly aids purgation. A teaspoonful of glycerin injected into the rectum, or one of the Suppositoria Glycerini, often unlocks the bowels

Intestinal Astringents.—These may be described under the following heads:—

Astringents acting on the vessels of the intestine. These are the same as those acting on vessels generally. Those employed for their action on the intestine are—

(1) **Lead salts.**
(2) Dilute **solutions of silver salts.**
(3) **Alum.**
(4) Dilute **sulphuric acid.**

Astringents coagulating albuminous fluids, and thus constricting the vessels:

(1) **Tannic acid**, and all substances containing it, as—
(2) **Krameria** root,
(3) **Kino,**
(4) **Hæmatoxylum,**
(5) **Cinnamon,**
(6) **Catechu,**
(7) **Eucalyptus gum,**
(8) **Hamamelis,**
(9) **Acacia Bark,**
(10) **Bael Fruit,**
(11) **Myrobolans,**
(12) **Lead salts,**
(13) **Silver salts,**
(14) **Zinc salts,**
(15) **Bismuth salts,**
(16) **Copper salts,** and especially
(17) **Per-salts of iron.**

Astringents diminishing the amount of intestinal fluid secreted:

(1) **Opium.**
(2) **Belladonna.**
(3) **Calcium salts.**

Astringents diminishing the contractions of the muscular coat of the intestines:

(1) **Opium.**
(2) **Belladonna.**
(3) **Hyoscyamus.**
(4) **Stramonium.**
(5) **Lime.**
(6) **Bismuth salts.**

Therapeutics.—The first proceeding in every case of diarrhœa is to remove its cause; if this can be done, it will probably subside. Often the cause is some irritating, indigestible food, and then it is advisable to give a mild purge, as castor oil or rhubarb, to get rid of it. Many cases of ordinary

diarrhœa are probably due to some slight enteritis, and then any one of the astringents that have been named will be valuable for it is desirable to constrict the dilated vessels, and to diminish the secretion and the movements. Intestinal astringents are therefore often combined, and when the diarrhœa is at all serious opium is of great service. If there is a persistent cause, as tuberculous ulceration, the hope of doing good is slight. But the treatment by drugs is only a small part of the battle: if the diarrhœa is severe, absolute rest is necessary, food must be very simple and given in very small quantities at a time, not much fluid should be drunk, and the patient must keep warm.

Intestinal Antiseptics.—It is doubtful if it is possible to disinfect the intestinal contents while they are in the body, and if it were possible it might be harmful, as intestinal micro-organisms greatly help normal intestinal processes. But the attempt is often made and perhaps with some success when soured milk (*q.v.*) is given to inhibit the growth of micro-organisms in the large intestine. The drugs used are lactic acid, calomel, and gastric antiseptics (p. 86), of which cyllin and similar coal tar products appear to be the most useful.

E. Drugs acting on the Liver.—The liver has several distinct functions, viz. to secrete bile, to form and store up glycogen, to form urea, to excrete substances absorbed from the intestine, and to destroy poisonous substances absorbed from the intestine.

Drugs influencing the secretion of bile.—It does not follow because more bile appears in the fæces that more is secreted, for it may be that the gall-bladder and ducts have been thoroughly emptied, or that the bile which has been poured into the duodenum has been swept along quickly before

reabsorption, which is ordinarily brisk, has had time to take place. Drugs which increase the amount of bile actually secreted are called direct cholagogues, or hepatic stimulants; but this is a bad name, as the liver has so many distinct functions: those which simply lead to a larger amount of bile being found in the fæces without any extra secretion are called indirect cholagogues.

DIRECT CHOLAGOGUES.—Drugs supposed to belong to this group have been studied in fasting curarized dogs, and upon human beings with biliary fistulæ. A canula is inserted into the bile-duct, and is brought out of the body, the drug to be experimented upon is administered, and the amount of bile secreted before and after the administration is noted. No food must be given during the experiment, as that alone causes a considerable increase in the biliary flow.

Direct cholagogue—**Bile.**

After bile is given by the mouth it is absorbed, carried to the liver, and there increases the secretion of bile.

The following were formerly stated to be direct cholagogues, but none of them increase the quantity of bile secreted (those formerly believed to be the most powerful are placed first)—

(1) **Euonymin.**
(2) **Sodium benzoate.**
(3) **Sodium salicylate.**
(4) **Podophyllum.**
(5) **Iridin.**
(6) **Mercuric chloride.**
(7) **Sodium sulphate.**
(8) **Sodium phosphate.**
(9) **Aloes.**
(10) **Ipecacuanha.**
(11) **Dilute nitric acid.**
(12) **Dilute nitro-hydrochloric acid.**
(13) **Colocynth.**
(14) **Colchicum.**
(15) **Potassium sulphate.**
(16) **Rhubarb.**
(17) **Jalap.**
(18) **Dilute arsenious acid.**

There are individual differences among such drugs; many empty the bowels producing a motion full of bile simply by hurrying on the contents of the small intestine, and hence they are indirect cholagogues. Some, as sodium salicylate,

make the bile very watery; others, as toluylenediamine, which is not given to man, make it so thick that it flows through the duct with the greatest difficulty. Podophyllum, iridin, euonymin, sodium benzoate, sodium salicylate, Harrogate old sulphur spring and Carlsbad water appear to increase the solids without affecting the quantity.

INDIRECT CHOLAGOGUES.—These cause no increase in the amount of bile secreted; they act either by stimulating the upper part of the jejunum and the lower part of the duodenum, thus sweeping the bile on before there is time for it to be reabsorbed; or because the purgative, *e.g.* jalap, or scammony, acts best on the intestine when dissolved in bile, and hence when there is plenty of bile in the intestine it is quickly expelled; or, lastly, possibly because the drug, *e. g.* calomel, is an antiseptic, and so prevents the decomposition of bile by bacteria.

They are—(1) **Mercury**, (2) most **Cathartic purgatives**, especially **Calomel**, (3) all the drugs mentioned in the last list (p. 101).

Therapeutics.—Cholagogues are used for cases of dyspepsia in which there is reason to believe that the liver is the organ at fault, and certainly they often have a very markedly beneficial effect. It is clearly an advantage to combine direct and indirect cholagogues in order to ensure that the bile shall be excreted. As bile itself is a stimulant to the peristaltic movements of the intestine, all cholagogues are purgatives, and form a distinct class of purgatives. In cases of hepatic dyspepsia attention to diet is of the greatest importance, and muscular movements, as riding, rowing, &c., aid in the expulsion of bile from the gall-bladder and ducts.

ANTICHOLAGOGUES.—These are often called hepatic depressants. They decrease the quantity of bile secreted. Castor oil, magnesium sulphate,

opium, and lead acetate have been said to have this effect, but it is not sufficiently marked to interfere with their therapeutic use for other purposes, and they are never employed for this action.

Drugs modifying the formation of urea by the liver.—It is believed that some of the nitrogenous substances, especially leucin, arriving at the liver, are there converted into urea. The quantity of urea excreted by the urine is increased by thyroid gland, phosphorus, arsenic, and antimony. Phosphorus may also lead to the appearance in the urine of leucin and tyrosin. There is some evidence that this drug causes an increase of the urea through its action on the liver, for in phosphorus poisoning that organ undergoes extreme fatty degeneration, and jaundice supervenes. Whether the other drugs act through the liver is doubtful. Antimony and arsenic, if given in large doses for some time, both produce general fatty degeneration. Both these must be administered in almost poisonous doses in order to increase the urea in the urine.

Excitants of the Glycogenic Function.—Adrenalin rapidly converts glycogen into glucose and so causes glycosuria.

Depressants of the Glycogenic Function.—Phosphorus, arsenic, and antimony diminish and even stop the formation of glycogen by the liver; they also cause fatty degeneration of it. In certain forms of diabetes, opium, morphine, and codeine diminish the quantity of sugar in the urine.

F. Drugs acting on the Pancreas.—The secretion of pancreatic juice is excited by acids, hence any of the drugs increasing the gastric juice (p. 85) and mineral acids stimulate it, but alkalies diminish it as they inhibit the gastric flow. Fats excite the pancreatic flow.

Division X.—Drugs acting on the Muscular and Nervous Systems.

A. Drugs acting on Muscles.—Pharmacologists have devoted much attention to this class of drugs, but as the facts ascertained are not used in medicine, we need not stop to consider them in detail (see caffeine, veratrine, potassium, and barium).

B. Drugs acting on the Peripheral Endings of Motor Nerves.—Of the drugs belonging to this group the action of curare has been worked out most fully. If curare is given to an animal, it is found that the muscles will respond to a mechanical stimulus, although they will not contract when the motor nerve is stimulated. If a single muscle be removed from the circulation by ligature of its vessels before the administration of curare, afterwards it will be the only one that will respond to stimulation of its motor nerve. As this was the only muscle of the body that the drug could not reach, and it is the only one not poisoned, the poison clearly acts locally on the muscles; but as the curarized muscle will respond to mechanical stimulation curare does not act on its fibres, and it is believed that the action falls on the myoneural junction.

Curare and conium are by far the most important drugs which paralyse motor nerve ends. Therapeutically we never desire to paralyse motor nerve endings.

C. Drugs acting on the Peripheral Endings of Sensory Nerves (other than those of special sense). Our knowledge of these is derived almost entirely from observations on man, for it is very difficult to experiment upon animals, as they have such imperfect means of communicating their sensations to us.

Drugs which stimulate the terminations of sensory nerves.—These, when applied locally, cause pain.

They are the same as the local vascular irritants which have already been enumerated (p. 59); in fact, most of them give rise to pain by causing local inflammation. There is no need to repeat the list.

Therapeutics.—Local irritants are chiefly employed for their action on the vessels, but as they are also counter-irritants, their application to the skin, while causing some pain there, will often relieve a deep-seated pain. Although pain is always referred to the periphery, it is appreciated centrally, and therefore peripheral stimulation of nerves, which also reflexly excites the heart and respiration, is used to rouse people from unconsciousness, such as that of fainting or opium poisoning. For these purposes the stimulus must be prompt, hence the application of the faradic current to the skin is a good means to employ.

Drugs which depress the terminations of sensory nerves.—Of these there are two kinds: those which only relieve pain, or local anodynes; and those which diminish sensibility, or local anæsthetics.

Local Anodynes.—These have but slight action unless pain be present. They are—

(1) **Aconite.**
(2) **Carbolic acid.**
(3) **Menthol.**
(4) **Orthoform.**
(5) **Veratrine.**
(6) **Ether.**
(7) **Alcohol.**
(8) **Chloroform.**
(These last three must be allowed to evaporate.)

(9) **Chloral.**
(10) **Chloretone.**
(11) **Belladonna.**
(12) **Stramonium.**
(13) **Hyoscyamus.**
(14) **Camphor.**
(15) **Sodium bicarbonate.**
(16) **Oxide of zinc.**
(17) **Dilute hydrocyanic acid.**

In the above list the most powerful are placed first. Many other substances are said to be local anodynes, but their claim to the title is doubtful. Cold is a powerful depressant of sensibility, and therefore it is an excellent local anodyne; so also is warmth, for heat dilates the vessels, and thus relieves tension, which is a very powerful factor in causing pain.

Therapeutics.—It is clear that the scope for the employment of local anodynes is very wide. If possible, the first thing is to remove the cause of the pain, but often, as in neuralgia and many forms of pruritus, we cannot do this.

Local Anæsthetics.—These are cocaine, benzamine, amylocaine, ethocaine, carbolic acid, kava root, quinine, urea hydrochloride, and extreme cold, whether produced by ice or ethyl or methyl chloride spray. These sprays are not so much employed as formerly to produce local anæsthesia for small operations, because they have been largely superseded by cocaine, which produces a high degree of local insensibility.

D. Drugs acting on the Trunks of Nerves.—These are of greater pathological than pharmacological interest. If taken for a long time they produce chronic inflammation of the nerves, which is shown by the great increase of the fibrous tissue between the nerve-fibres, and the fatty degeneration of the fibres themselves. During the earlier stages the irritation of the nerves causes much pain and tingling; later, as they lose their function, numbness, with loss of sensation, and paralysis set in, often accompanied by trophic lesions. For fuller details, books on medicine must be consulted.

The drugs producing peripheral neuritis are—

(1) **Lead.**
(2) **Alcohol.**
(3) **Arsenic.**
(4) **Mercury.**

E. Drugs acting on the Spinal Cord.—The difficulties of experiment are so great that we know nothing of the action of drugs on the sensory portions of the cord. We are also ignorant of the action of drugs on the motor fibres. The following

method is adopted to discover whether a drug acts on the anterior cornua. Suppose we are studying a drug which stimulates them. After the drug has been given, a slight peripheral stimulus will produce such marked reflex action that convulsions will ensue upon the stimulation. If the cord is cut across and the convulsions follow the stimulus as before, it is clear that these cannot be of cerebral origin, for in that case they would not take place below the point of section. Again, if before injection of the drug into the circulation the vessels of the cord are ligatured, and then the drug causes no convulsion, it is clear that it acts on the cord and not on the muscles or nerves. These results are confirmed if, when the drug is injected into vessels by which it reaches the cord quickly, convulsions occur sooner than when it is thrown into other vessels; also if convulsions do not take place when the cord is destroyed; and lastly if, when the destruction is gradually caused by pushing a wire down the vertebral canal, the convulsions cease from above downwards as the cord is destroyed. Strychnine has been much more fully studied than any other drug which acts on the cord. The effect of it is to convert what would normally be inhibitory impulses into excitory (*see* Strychnine).

The drugs increasing the irritability of the anterior cornua are—

(1) **Strychnine.**
(2) **Brucine.**
(3) **Thebaine.**
(4) **Ammonia.**
(5) **Chloroform.**
(6) **Ether.**

Therapeutics.—It is very rarely that we can do any good in spinal diseases by attempting to stimulate the anterior cornua, but strychnine is occasion-

ally given for cases of paralysis due to disease of the spinal cord.

Drugs which depress the activity of the anterior cornua:

(1) **Physostigmine.**	(10) **Antimony salts.**
(2) **Bromides.**	(11) **Nitrites.**
(3) **Alcohol.**	(12) **Chloral.**
(4) **Chloroform.**	(13) **Carbolic acid.**
(5) **Ether.**	(14) **Turpentine.**
(6) **Ergot.**	(15) **Gelsemium.**
(7) **Opium.**	(16) **Colchicum.**
(8) **Zinc salts.**	(17) **Kava root.**
(9) **Silver salts.**	

Therapeutics.—These drugs are of very little use in medicine for their action on the spinal cord. Physostigmine is by far the most powerful, and has been occasionally used in obscure nerve diseases accompanied by convulsions, as tetanus.

Ergot has a very peculiar action in producing sclerosis of the posterior columns of the cord. Lead sometimes causes atrophy of the anterior cornual cells, and long-continued abuse of alcohol probably causes slight degeneration of the cord as a whole.

F. Drugs acting on the Brain.—The action of these cannot be localised nearly so accurately as can that of drugs acting on the spinal cord and nerves. Drugs acting on the brain illustrate two very important general laws.

First, the law of dissolution, which, when stated as it applies in pharmacology, is as follows. When a drug affects functions progressively, those first affected are the highest in development; that is to say, they are the last acquired by the individual and the last to appear in the species. The next affected are those next to highest, and so on; till finally the lowest of all from an evolutionary point of view, that is to say, the functions of respiration and circulation, are affected. This law is very well exemplified in

the case of alcohol, for the first functions to be disordered are those of the intellect, especially the highest, such as judgment and reason; then follow disorders of movement, and finally death from failure of respiration and circulation.

Another law very well exemplified by drugs which act on the brain is that when a drug in moderate doses excites a function, in large doses it often paralyses it. For example, a person under the influence of chloroform, soon after its administration, tosses his arms about in a disorderly way, but they subsequently become motionless; and many other cerebral stimulants may also be hypnotics. Some think that drugs excite nervous functions by direct action, others that the excitation is often due to the removal of inhibitory impulses.

Drugs acting on the motor centres of the brain.—To investigate these, the motor area of the cortex is exposed by trephining, and the strength of current which it is necessary to apply to the motor area to produce corresponding movements is noted before and after the administration of the drug. Another method is to observe the strength of current necessary to evoke a movement, then to allow the trephine wound to close, afterwards the animal is made to take the drug regularly for some weeks. The opposite motor area is then exposed, and the strength of current required to call forth movements is noted.

It has been found that

(1) **Alcohol,**	(4) **Potassium bromide,**
(2) **Anæsthetics,**	(5) **Sodium bromide,**
(3) **Chloral,**	(6) **Ammonium bromide,**

diminish the activity of the motor area.

Bromides are largely used in epilepsy and other convulsive disorders on account of this function.

Drugs exciting the motor area of the cortex are—

(1) **Atropine.**
(2) **Absinthe.**
(3) **Strychnine.**

They have no therapeutical application in virtue of this property.

General cerebral stimulants.—It is impossible to know anything of these by experiments on animals. In man they cause general excitation of the mental faculties, followed in many cases by delirium and incoherence. The exact form of delirium differs a little in each case.

Such drugs are—

(1) **Belladonna.**
(2) **Stramonium.**
(3) **Hyoscyamus.**
(4) **Alcohol.**
(5) **Chloroform.**
(6) **Ether.**
(7) **Nitrous oxide.**
(8) **Coffee.**
(9) **Tea.**
(10) **Guarana.**
(11) **Cocaine.**
(12) **Cannabis indica.**
(13) **Opium.**
(14) **Camphor.**
(15) **Santonin.**
(16) **Quinine.**
(17) **Salicylic acid.**
(18) **Tobacco.**

Therapeutics.—Many of these are taken habitually as cerebral stimulants; for example, alcohol, tea, coffee, tobacco, in England; opium in the East; cannabis indica in many parts of Asia; coca in parts of South America; and if it is wished to give a cerebral stimulant as a drug, one of these is usually chosen. The rest, which are very important, are commonly employed for some other action. With very many of this class of drugs, as will be seen directly, the stimulant action soon gives way to a paralysing influence.

General cerebral depressants.—These are commonly divided into three classes: Hypnotics or Soporifics, Narcotics, and Anæsthetics. It is believed that one way at least in which any drug depresses

the activity of a neurone is by causing retraction of the terminal filaments of its dendrons or axon, thus rendering synapses less intimate. During depression of activity the brain is anæmic, but this is the result more than the cause of the depression.

HYPNOTICS OR SOPORIFICS are drugs which produce sleep, closely resembling, if not identical with, natural sleep.

The hypnotics are—

(1) **Opium.**
(2) **Morphine.**
(3) **Diamorphine.**
(4) **Chloral hydrate.**
(5) **Butyl - chloral - hydrate.**
(6) **Bromides.**
(7) **Chloral formamide.**
(8) **Chloralose.**
(9) **Chloretone.**
(10) **Sulphonal.**
(11) **Methylsulphonal.**
(12) **Paraldehyde.**
(13) **Barbitone.**
(14) **Medinal.**
(15) **Adalin.**
(16) **Alcohol.**
(17) **Hyoscine.**
(18) **Cannabis indica.**

Therapeutics.—These drugs are often used for persons suffering from sleeplessness, but it is far more important to remove the cause of the sleeplessness. Sleep is often promoted by dilating the vessels of other parts of the body than the brain; for example, a warm bath or an abundant meal conduces to sleep. The use of hypnotics is greatly abused. Those who take them become habituated to them, so that at last even large doses do not cause sleep. Chloral, the bromides, methylsulphonal, and chloral formamide are perhaps the most satisfactory.

NARCOTICS are substances which produce abnormally deep sleep. Most hypnotics in excessive doses will do this. General anæsthetics are narcotics. It has been suggested by Meyer and Overton that as many of these substances, *e.g.* ether, sulphonal, methylsulphonal, chloroform, chloral, and chloral form-

amide, are more soluble in lipoids than in water, they will accumulate in the nervous system, where these substances are chiefly present, and that this helps to explain the action of these drugs. This may be so, but many hypnotics, *e.g.* bromides, are not specially soluble in lipoids, and many substances are soluble in them but are not hypnotics, so this question of solubility cannot be the whole explanation, although no doubt it is operative.

Therapeutics.—They are of great use in calming excitement of any kind; many of them, such as, for example, opium, are beneficial in relieving distress and producing sleep in heart disease.

General Anæsthetics.—These are drugs that lead to a total loss of consciousness, so that pain is no longer felt; at the same time reflex action is abolished. They illustrate admirably the law of dissolution, and also the fact that after excitement paralysis often succeeds; and the stages consequent upon these laws can be readily observed in any one who is taking an anæsthetic. Firstly, in obedience to the law of dissolution the highest faculty, the imagination, becomes excited, the patient sees visions and hears noises. He next begins to chatter wildly and incoherently, for in the excitement of any function by a drug the exaltation is usually irregular, and confusion results. Next, the other motor centres of the cortex are stimulated irregularly, so that he gesticulates, throws his arms about wildly, and tosses his body. By this time the brief stimulation of the higher intellectual faculties has probably ceased, and in obedience to the second law (p. 109) vision, hearing, and touch are dulled, and he has lost control over his reason, so that he feels light-headed, as he expresses it, crying and laughing easily; now he is totally irresponsible for his actions and careless as

to their results. It will be noticed that the functions are paralysed in the order stated in the law of dissolution. Next there follows upon the stimulation of the motor areas stimulation of the heart and respiration. The pulse and respirations both increase in number, the blood-pressure rises, the face flushes. Then comes depression of all the functions previously excited; first the higher parts of the cerebrum give way, and the patient loses consciousness—neither bright lights, sounds, nor painful impressions rouse him; he becomes quiet, and ceases to throw his arms and legs about; the reflexes disappear, and consequently touching the conjunctiva does not produce closing of the eyelid; the feet do not move when they are tickled, the pupil is contracted, and the previous quickening of the pulse and respiration is succeeded by a slowing of their rate. It is at this period that the patient cannot feel pain, and that therefore operations are performed. The depression of the motor centres is followed by the depression of the muscular tone, and the muscles become quite flaccid and cease to respond to mechanical stimulation. This is the degree of narcosis that is required for the easy reduction of dislocations and for the easy manual examination of the abdominal viscera. Anæsthetics should not be pushed beyond this stage. If they are, even the involuntary muscles lose their tone and reflex excitability, so that the sphincters of the rectum and the bladder relax. The depression of the pulse and respiration continues, the movements of the chest become weaker and weaker and slower and slower, the pulse becomes very feeble, slow, and irregular, and the heart finally stops in diastole. Death occurs partly by the heart and partly by the respiration. At any period of the administration during which recovery is possible, the functions of the body will return in just the reverse order to

that in which they were lost, thus again illustrating the law of dissolution. It is often many hours before the mental faculties have recovered their equilibrium, and long after the patient can move his muscles he cannot co-ordinate them. There are individual differences in the different anæsthetics and in different persons.

The general anæsthetics are—

(1) **Chloroform.**
(2) **Ether.**
(3) **Nitrous oxide.**
(4) **Many other substitution products** derived from alcohols and ethers.

Therapeutics.—Anæsthetics are given to cause unconsciousness, so that pain may not be experienced during operations, to relax muscles in cases of dislocations, abdominal examinations, or phantom tumours, to relieve severe pain, such as that of parturition, biliary and renal colic, to quiet the body during convulsions, as in tetanus and hydrophobia.

The chief dangers of anæsthetics are—1. Early sudden death. This usually occurs before the patient is fully under the influence of the anæsthetic, reflex action is not yet quite abolished, and the heart is stopped reflexly from the peripheral stimulus of the operation. This is one of the greatest and most common dangers of anæsthetics, especially chloroform. It is, to a large extent, avoidable if care be taken that the patient is fully under the influence of the anæsthetic before the operation is begun; occasionally when it is trivial the operator is in too great a hurry to begin, and the patient suddenly dies from failure of the heart.

2. Death from paralysis of respiration. This is usually due to a combination of circumstances. Too much of the anæsthetic may have been given,

respiration may be difficult because the patient suffers from some disease of the lungs, or the operation may demand that he should lie on his side or in some other position which hampers respiration. It is not a very great danger, for it is heralded by lividity; and if then the posture is changed, the administration of the anæsthetic is stopped and artificial respiration is performed, the patient usually quickly recovers; even if he does not, artificial respiration with the head thrown back and the tongue pulled out should be carried on as long as there is any evidence that the heart is beating, or if the patient draws a breath when artificial respiration is stopped for half a minute. Cases have recovered although it has been necessary to keep up artificial respiration for hours.

3. Cardiac failure may occur, owing to overdosage acting directly on the heart and to a much less extent on the vagal centre, especially if the vapour is too concentrated. The patient almost suddenly becomes pale, and the pulse stops. In such a case no more anæsthetic must be given, artificial respiration must be kept up in the manner just mentioned, and the heart may be stimulated by the subcutaneous injection of brandy, by the inhalation of amyl nitrite, by the application of the faradic current over the cardiac region, by the plunging of electric needles into the heart, by flicking the chest over the heart with hot towels and placing hot compresses over it, or even by opening the abdomen and compressing the heart through the diaphragm. The feet should be raised and the head depressed.

4. Vomited matter and, if the operation is about the mouth, blood may suffocate the patient. To avoid the first contingency no food should be taken for some time before the operation, and if the patient is sick he should be turned on his side; to avoid the

second special precautions must be taken, which are described in books on operative surgery.

5. Reduction of body temperature due to diminished activity and to vasodilatation of the vessels of the skin. This is minimised by keeping the surroundings of the patient as warm as possible during the operation, and by the use of hot blankets and hot bottles afterwards.

For the relative advantages of the different anæsthetics and the mode of giving each, the account of the individual drugs must be consulted.

G. Drugs acting on the Eye.

1. **Drugs acting on the Pupil.**—The first thing to determine is whether any drug which dilates or contracts the pupil acts locally or centrally. It is dropped into one eye: if it only acts feebly and after some time and on both eyes, it follows that it has acted centrally after absorption from the conjunctiva into the general circulation; but if it acts quickly, powerfully, and only on the eye into which it was dropped, its action is local. If it acts on an excised eye its action must be local. If, when all the vessels going to the eye are ligatured, the drug will act when dropped into the eye, but will not when thrown into the general circulation, this again shows that its action is local, and that when it acts after being thrown into the circulation when no vessels are ligatured it does so because it is circulating locally through the eye. If all the arteries and veins of the eye are ligatured, and the drug will not act when locally applied, although it would before, and will now when thrown into the general circulation, it shows that its action is central, and that it acts when dropped into the eye because some of it is absorbed.

If it has been proved by these means to act centrally the further investigation is difficult, for the central mechanism is complex.

If it has been proved to act locally, it may act either on the muscular fibres of the iris, on the terminations of the third nerve in them, or on the terminations of the cervical sympathetic in them. Stimulation of the third nerve causes the pupil to contract; section of it causes the pupil to dilate. Stimulation of the sympathetic causes the pupil to dilate; section of it causes the pupil to contract. If the pupil is dilated by the local action of a drug, and stimulation of the third nerve will not cause it to contract, but yet the muscle is responsive to mechanical stimulation, it shows that the endings of the third nerve are paralysed. If the pupil is contracted by the drug, and although responsive to mechanical stimulation, will not dilate when the third nerve is cut, it shows that the ends of the third nerve are stimulated. If a drug locally dilates the pupil, but not as powerfully as stimulation of the sympathetic, it is clear that its whole effect is not due to a stimulation of the sympathetic; and if the muscle remains locally irritable, the third nerve ending must be paralysed. A series of similar experiments may be made with regard to the sympathetic. By these means the mode of action of many drugs has been made out, but often they act both on the sympathetic and the third nerve. In the following list they will be classified under their main actions.

Mydriatics (*pupil dilators*)—

A. Paralyse the terminations of the third nerve.

(1) **Atropine.**
(2) **Homatropine.**
(3) **Hyoscyamine.**
(4) **Coniine.**
(5) **Aconite.**
(6) **Amyl nitrite.**

It is not quite certain how the last three act, but probably on the ends of the third nerve.

B. Stimulate the terminations of the sympathetic.—**Cocaine, Adrenalin.**

C. Act centrally.—**Gelsemine anæsthetics** (late in their action).

Myotics (contract the pupil).

A. Stimulate the terminations of the third nerve.—**Physostigmine, pilocarpine, nicotine** (probably).

B. Act centrally.—**Anæsthetics** (early in their action), **opium.**

Therapeutics.—Dilators of the pupils, especially atropine and homatropine, are used to dilate the pupil for ophthalmoscopic examination, and to prevent or break down adhesions of the iris. Contractors of the pupil, especially physostigmine, are used to overcome the effects of atropine, and to prevent too much light entering the eye in painful diseases of it.

2. **Drugs acting on the Ciliary Muscle.**—The following drugs impair or paralyse accommodation:

(1) **Atropine.**	(5) **Physostigmine.**
(2) **Hyoscyamine.**	(6) **Pilocarpine.**
(3) **Homatropine.**	(7) **Gelsemine.**
(4) **Cocaine.**	(8) **Coniine.**

Intra-ocular tension is increased by atropine (large doses), homatropine, hyoscyamine, pilocarpine. It is decreased by cocaine, and physostigmine.

Gelsemine paralyses the external ocular muscles, especially the levator palpebræ and the external rectus, by its action on the terminal nerve filaments.

Cocaine stimulating the unstriped fibres in the orbital membrane and the eyelids causes the eye to protrude.

Coniine produces ptosis.

The capacity for seeing blue is increased by strychnine. Santonine causes first violet, then yellow vision.

H. Drugs acting on the Ears.—We know very little about the action of drugs on these. Quinine and salicylic acid cause noises and buzzing.

I. Drugs acting on Sympathetic System.—The curious fact has been made out that if an animal be treated with a large dose of nicotine, or if this be applied locally to the superior cervical or other peripheral nervous ganglia, stimulation of the nerve below the ganglion no longer produces its characteristic effects, *e.g.* constriction of the ear vessels, dilatation of the pupil, secretion of saliva, although stimulation above the ganglion does. The ganglion cells are clearly paralysed. A small dose at first excites them. Curare, lobelia, and coniine have the same effect on ganglia, and so produce effects on the heart, vessels, and secretions which have been described on pp. 57 and 62. Sphacelinic acid stimulates sympathetic ganglia and is thus antagonistic to nicotine.

Division XI.—Drugs acting on the Organs of Generation.

A. Aphrodisiacs.—These are substances which increase sexual desire. There are conceivably many ways in which this might take place. There is a centre in the lumbar spinal cord, irritation of which causes erection, and this is capable of being excited by afferent impulses proceeding from many parts of the body, but especially from the cerebrum, and the genital organs themselves, or the parts in their immediate neighbourhood. The lumbar centre appears to be very dependent upon the general health, and therefore substances which improve this are indirectly aphrodisiacs.

The following drugs have been used as aphrodisiacs; their mode of action is not certainly known.

(1) **Strychnine.**
(2) **Cantharidin.**
(3) **Alcohol.**
(4) **Cannabis indica.**
(5) **Camphor.**
(6) **Phosphorus.**
(7) **Damiana.**

B. Anaphrodisiacs.—We do not know for certain of any drugs which have a depressant effect upon the lumbar centre. Most anaphrodisiacs act by decreasing or removing some irritation which is reflexly producing an aphrodisiac effect, but some probably act centrally.

Drugs which have been used as anaphrodisiacs are—

(1) **Bromides.**
(2) **Iodides.**
(3) **Opium.**
(4) **Belladonna.**
(5) **Hyoscyamus.**
(6) **Stramonium.**
(7) **Digitalis.**
(8) **Purgatives.**

C. Ecbolics or Oxytocics are remedies which during or immediately after parturition increase uterine action.

They are—

(1) **Ergot.**
(2) **Pituitary Extract.**
(3) **Quinine.**
(4) **Hydrastis.**
(5) **Savin** (B. P. 1885).
(6) **Rue** (B. P. 1885).
(7) **Powerful purgatives.**
(8) **Suprarenal Extract.**
(9) **Cotton Root Bark.**

Of these ergot and pituitary are by far the most important. Occasionally some of these drugs will act upon the gravid uterus to produce abortion before parturition has begun. They have almost all been used criminally for this purpose.

D. Emmenagogues are substances used to increase the menstrual flow. Diminution of the menstrual flow is a symptom of so many diseases that a large number of drugs which remedy these are indirect emmenagogues, but the substances which have been said to have a special action in increasing the menstrual flow are—

(1) **All Ecbolics.**
(2) **Asafetida.**
(3) **Myrrh.**
(4) **Cantharidin.**
(5) **Borax.**

Among the many indirect emmenagogues the commoner are purgatives, iron, manganese, cod-liver oil, and strychnine,

which act by improving the general health. Hot foot or hip baths, [illegible] be added, often aid the onset of menstruation.

E. Substances which depress Uterine Action.—These are employed to restrain the contractions of the gravid uterus. They are—

(1) **Bromides.**
(2) **Opium.**
(3) **Chloral.**
(4) **Cannabis indica.**
(5) **Chloroform.**

F. Drugs acting on the Secretion of Milk.

Galactagogues, or drugs which increase the secretion of milk.

Pituitary Extract, Pilocarpin, and **Alcohol.**—Of these the first two are the most powerful, but the effects soon pass off. Alcohol is very feeble. The secretion is so much under the control of the general health that the best way to ensure an abundant secretion is to keep the general health as good as possible.

Antigalactagogues, or drugs which decrease the secretion of milk.

Belladonna, either given internally or applied locally, is very efficient, probably acting locally on the mammary gland as on the sweat glands.

The following *drugs*, if given, are *excreted by the milk*, and are therefore taken in by the child:—Oil of anise, oil of dill, garlic, oil of turpentine, oil of copaiba, and probably all volatile oils, sulphur, rhubarb, senna, jalap, scammony, castor oil, opium, iodine, indigo, antimony, arsenic, bismuth, iron, lead, mercury, zinc, potassium iodide. It is clear that these must be administered with care to the mother; for example, copaiba or turpentine will make the milk so nasty that the child will not take it. The above purgatives given to the mother may cause diarrhœa in the child. Opium should not be given in large doses to the mother. On the other hand, mercury, arsenic, and potassium iodide may be administered to the child by being given to the mother. Salvarsan given to the mother will cure syphilis in the suckling child.

Division XII.—Drugs acting on Metabolism.

Our knowledge of the normal metabolism of the body is very imperfect, consequently we know very little more than has been already stated under other divisions, about the action of drugs on metabolism. Any further remarks which are necessary will be made when the individual drugs are considered. Two words in common use are alterative and tonic.

Alterative is a vague term of which nosatisfactory definition can be given. It is often used to cloak our ignorance, when we have no exact knowledge of the mode of action of a drug. Many drugs comprehended under this term have the property of profoundly altering the body, especially if it be diseased; for example, iodides will, if the patient be suffering from syphilis, generally cause the absorption of syphilitic exudations. All that can be said about such drugs will be stated under each, for their mode of action is probably so different that no useful purpose would be served by considering them together.

Tonic.—This is a term usually even more vague than alterative. As commonly employed, it means a drug which makes the patient feel in more robust health than he did before he took it. Obviously this may happen in many ways, such as, for instance, by improving the digestion or the quality of the blood. The word is only used justifiably when applied to a drug which increases muscular tone.

MATERIA MEDICA.

(All the substances about to be described are official, being in the British Pharmacopœia of 1914, unless the contrary is stated.)

PART I.—INORGANIC MATERIA MEDICA.

GROUP I.

Water, Peroxide of Hydrogen, and Oxygen.

AQUA DESTILLATA.

Distilled water, H_2O.

SOURCE.—Prepared by distillation from good natural potable water.

TESTS.—Colourless, odourless, and tasteless. 100 millilitres evaporated to dryness leave not more than 0·005 grm. of solid residue. It is not affected by tests for metals, chlorides, nitrates, nitrites, or sulphates. Tested with sulphuric acid and potassium permanganate, it should only show faintest traces of organic matter, and tested with Nessler's test it should only show the faintest traces of ammonia. Aqua destillata is always to be used for making up prescriptions.

ACTION.*

External.—An indifferent bath (88°–98° F. or about 32°–37°C.), or one in which the bather feels neither hot nor cold, produces no particular effect.

Cold baths increase the production of heat, and abstract heat from the body if they are prolonged; therefore at first the bodily temperature may rise slightly, but when the loss exceeds the production it falls. The amount of carbonic acid expired is in-

* Unless otherwise stated, the word action will in this book always be taken to mean physiological action, or action in health.

creased. The rato of the pulse and respiration at first rises, but soon falls. The skin becomes pale, and tho condition of gooso-skin is seen. After the bath (the duration and temperature suitable for different persons vary widely) thore is a feeling of warmth and exhilaration, and the cutaneous vessels dilate.

A warm bath if sufficiently prolonged may cause a slight rise of the bodily temperature, the skin becomes red, the pulse and respirations are more frequent, the amount of urine secreted is diminished, and after the bath thoro is profuse perspiration.

Internal.—Warm water gives rise to nausea and vomiting. Water is very slowly absorbed from the stomach, but quickly from tho bowels, and very soon afterwards the amount of urine secreted is greatly increased, and to a less degree tho amount of bile, pancreatic juico, and saliva. Moderate quantities of water promoto the flow of gastric juice, but large amounts should not be drunk during meal-times, as that impairs digestion. If a considerable amount of water is drunk daily the amount of urinary nitrogen excreted is increased. Water not only washes out the tissues, but renders tissue metamorphosis more complete.

The action of water will be physically modified by the substances in solution in it, for there will be no physical interchange between isotonic solutions. But water passes from a hypotonic to a hypertonic solution, *e.g.* when red blood corpuscles are placed in a salt solution of such concentration that fluids pass from the corpuscles to it they shrink; but when they are placed in a weaker solution of such strength that fluid passes from the solution to them they swell. In the first case the salt solution is called hypertonic, in the second hypotonic as regards the corpuscles.

Therapeutics.

External.—*Cold baths* are used for the subsequent exhilarating effects, which may be increased by quick rubbing with a rough towel. Persons in whom a feeling of warmth does not immediately follow a cold bath should not use them. The constant daily use of a cold bath probably diminishes the liability to catch cold. Cold baths are said to arrest attacks of laryngismus stridulus. They have been largely used to reduce the temperature in fever, especially typhoid fever. The first effect of putting the patient in the cold water is to cause, reflexly from the stimulation of the skin by the cold, an increased production of heat; for this reason and because of the cessation of radiation, the rectal temperature at first rises a little, but soon, owing to the direct abstraction of heat, and to the diminished production of heat which quickly sets in, it falls rapidly, and continues to do so after the patient is taken out. The temperature of a bath for a patient with typhoid fever should be between 68° and 58° F. (20° and 14° C.); he should be lowered into it by a sheet, and remain in ten minutes, unless before that time he shows signs of collapse; he is then lifted back to bed, where a blanket is thrown loosely over him. If this treatment is adopted the bath ought usually to be given whenever the axillary temperature is 103° F. (39·5° C.). Sometimes the patient is placed in a bath at a temperature 10° F. (5° to 6° C.) below his own, and the water is cooled by putting in cold water or ice, till it has fallen to about 68° F. (20° C.), when he is taken out. Often instead of having a bath he is sponged with cold water as he lies in bed; this saves trouble, but both sponging and a cold pack (which consists of a sheet four folds thick wrung out in cold water and wrapped round the naked

body for five or ten minutes) are inferior to a bath. Pneumonia may be treated by the application of cold, generally by means of ice poultices applied to the chest. To make an ice poultice, put on a piece of gutta percha tissue a layer of wood wool, then one of powdered ice sprinkled with a little salt, turn over the edge of the gutta percha—which has been left wide enough—so as to cover in the poultice, and seal the edges with a little chloroform or turpentine. Put the poultice in a flannel bag, and bind it on the body where desired, with lint between it and the skin. The immediate application of cold baths is by far the best treatment for any sudden hyperpyrexia.

Cold is applied locally either by cold water in Leiter's coils or ice bags, in a number of conditions, with the object of arresting inflammation. Thus ice bags are put on the head in meningitis, or concussion, and on the knee-joint for acute synovitis, &c. According to some authorities cold contracts not only the vessels of the skin to which it is applied, but by reflex action those of the organs underneath it. Hence the application of an ice bag to the chest to arrest pulmonary hæmorrhage. Cold locally applied is therefore hæmostatic.

Warm baths, as they liquefy the fatty secretions, are more cleansing than cold. Hot baths, like any other application of heat, soothe pain, hence they are useful for rheumatoid arthritis and colic, whether renal, biliary, or intestinal. By bringing blood to the skin, and lessening the amount in the internal organs, they relieve muscular spasm, such as we find in stricture of the urethra, colic, laryngismus stridulus, other forms of laryngeal spasm, and infantile convulsions. In the same way they are of service in weariness from muscular or cerebral activity, and are useful in many inflammatory affections, as, for example, a cold in the head. A warm bath immediately before going to bed may sometimes cure

insomnia. The subsequent increased perspiration makes hot baths and hot packs of great value in the various forms of nephritis and in uræmia. Great care must be taken after a hot bath which has been given to induce sweating to see that the patient is kept warm by being wrapped quickly in a hot blanket and put into a warm bed; if not, the cutaneous vessels soon contract, and there is no diaphoresis. A local hot bath has the same effects, but to a less degree. A hot foot bath is often used for a cold in the head, or for amenorrhœa. Sponging with hot water will, by the vascular dilatation and sweating it causes, reduce the temperature slightly in fever.

A cold bath is one the temperature of which is below 70° F. (21° C.), one between 88° and 98° F. (32° and 37° C.) is properly speaking indifferent, but it is often called a warm bath. A tepid bath is intermediate between warm and cold. Anything above 98° F. (37° C.) is a hot bath. Few people can bear a temperature much over 102° F. (39° C.).

Internal.—The chief therapeutic use of water is to wash out the tissues, especially the kidneys, and to keep the urine dilute. Some persons who are liable to the formation of gravel or urinary calculi can by drinking plenty of pure water prevent their formation, for the minute collections of crystals which are the beginning of all calculi are washed out of the urinary system before they have time to grow to any size, and if they are composed of uric acid the copious drinking of water diminishes the liability of their formation, for it decreases the amount of uric acid excreted. It is stated that the liability to the formation of gall-stones may also be kept in check by the drinking of plenty of water, as then the bile becomes less concentrated and flows more quickly. When large quantities of water are drunk it should usually be pure distilled water, and should be taken between

meals. A glass of cold water taken on rising in the morning will with some persons cause the bowels to be opened. Warm water is an emetic.*

LIQUOR HYDROGENII PEROXIDI.

An aqueous solution of Peroxide of Hydrogen, H_2O_2.

SOURCE.—Prepared by the interaction of water, barium peroxide, and a dilute mineral acid at a temperature below 10° C.

TESTS.—When tested it should yield between nine and eleven times its volume of oxygen, but it is often met with yielding 20 or 30 volumes.

CHARACTERS.—Colourless, odourless liquid; slightly acid taste. Renders the saliva frothy.

Dose, ½ to 2 fl. dr.—2 to 8 mils.

USES.

As it easily parts with oxygen it is a powerful disinfectant (it is the active ingredient of Sanitas), and may be applied to ulcers. It is an admirable application for diseases of the gums as a 1 in 8 solution. Its disadvantage is its instability. It bleaches and is used as a hair dye. Internally it has been recommended for many diseases, but there is no proof of its efficacy. It is dangerous if given subcutaneously, or used to wash out serous cavities, for it is quickly decomposed; and if more oxygen is formed than the blood can dispose of, gas emboli are produced, and these, lodging in the lungs or brain, may cause death.

OXYGEN. (Not official.)

Compressed oxygen gas is sold in cylinders containing 12 or 20 cubic feet. A rubber tube with an inhaler at the end can be attached. In the course of the tube sometimes there is a large rubber bag to prevent the compressed oxygen issuing from the inhaler with too great force. Usually far

* It is impossible in this book to give more than a brief sketch of baths and drinking of waters. Further information will be found in works on 'General Therapeutics.'

too little oxygen is given and the inhaler is not kept long enough or close enough to the patient's mouth and nose. The inhaler can easily be arranged so that the patient expires into the air and inhales oxygen. Many patients can bear it applied to the nose and mouth for hours together, but if because of cough or secretion they cannot, oxygen may be administered continously by a rubber catheter passed up the nose.

Action and Therapeutics.

Oxygen inhalations are used in pneumonia, bronchitis, heart disease, and any other state in which the condition of the lungs interferes with the proper absorption of oxygen by the blood. Clinically the indication for oxygen inhalations is great lividity. This they will often relieve, and they may help a patient to tide over a temporary risk of death from want of oxygen, and even if they fail to avert death, they often render the end less distressing. They make the pulse slower. The gas should be allowed to issue in a gentle stream; as it comes out of the cylinder very cold, the tube conducting it should be surrounded by hot water if the patient complains that the gas irritates him. Often it is made to bubble through a little strong brandy and water placed in the bottom of a large bottle. The explanation of the benefit in the above diseases is not that the blood absorbs more than the normal amount of oxygen, but that, owing to the state of the lungs and the blocking of the air cells by exudate, the oxygen in the ordinary air cannot diffuse into the blood rapidly enough, but the inhalation of oxygen leads to a quick diffusion of it, and hence the normal amount can be absorbed. That taken in solution in the plasma is especially valuable, for it is readily given to the tissues.

GROUP II.

THE ALKALINE METALS.

Potassium, Sodium, Ammonium, Lithium.

POTASSIUM.

Symbol, K. Atomic weight 39·10. (Not official.)

When taken by the mouth, potassium salts are excreted as quickly as they are absorbed, so no effect is produced by the potassium ion, but this is really powerfully depressant to all nerve and muscle tissue, as is shown by local application or subcutaneous injection, in which case excretion is not nearly so rapid as absorption.

1. Liquor Potassæ.—Solution of Caustic Potash. KHO.

Source.—An aqueous solution of potassium carbonate is boiled with slaked lime. The supernatant liquid is syphoned off. $K_2CO_3 + Ca(OH)_2 = CaCO_3 + 2KHO$.

Characters.—A colourless alkaline fluid with a soapy feel and taste. Sp. gr. 1·045. To be kept in green glass bottles with air-tight stoppers.

Strength.—5 per cent., 5 gr. in 110 ♏, 5 grm. in 100 millilitres of potassium hydroxide in water.

Impurities.—Carbonic acid, lime, sulphates, chlorides and alumina.

Incompatibles.—Acids, acid salts, metallic salts and preparations of ammonia, belladonna, hyoscyamus and stramonium, the alkaloids of these three being decomposed by Caustic Potash. All alkaloids are precipitated by alkalies.

Dose, 10 to 30 m.—6 to 18 decimils—freely diluted.

2. Potassa Caustica.—Caustic Potash. Potassium Hydroxide. KHO. *Synonym.*—Potassæ hydras.

Source.—Obtained by the interaction of potassium carbonate and calcium hydroxide. It contains not less than 85 per cent. of pure potassium hydroxide.

Characters.—Hard, deliquescent, corrosive white pencils.

Impurities.—The same as of liquor potassæ.

Action of Potash.

External.—It is, if concentrated, a powerful irritant and caustic, acting by abstracting water from the part to which it is applied. It dissolves

fatty matters that may be present on the surface. It is antacid, and, if freely diluted, sedative.

Internal.—*Mouth.*—Alkalies have a soapy taste, and if sufficiently concentrated irritate the mouth, making the mucous membrane red.

Stomach.—Alkalies in medicinal doses do not influence the amount of gastric secretion but render the mucous less tenacious. (For large doses *see* Toxicology, p. 144.) If they are given after a meal the gastric juice already secreted is neutralized. Being readily diffusible they are quickly absorbed.

Intestine.—Alkalies lessen the pancreatic secretion, as they neutralize the acid gastric juice which excites it. The bile is uninfluenced.

Blood.—All alkalies circulate in the blood as bi-carbonates and phosphates. Their presence is very transitory, for they are quickly excreted. The amount of hæmoglobin, if it is deficient, is said to be increased.

Heart.—Very large amounts of potassium salts are depressant to all muscular tissues, and therefore decrease the force of the heart, causing diastolic arrest by direct action on its muscle. Therapeutic doses are never sufficient to act as depressants.

Kidneys.—Alkaline potassium salts are diuretic, acting directly on the renal epithelium. They are quickly excreted in the urine, rendering it alkaline, but to facilitate the solubility of uric acid very large doses must be given.

Respiratory passages.—The bronchial secretion is generally increased, and is rendered less viscid, but with some cases of bronchitis it is diminished.

Muscle and Nerve.—The prolonged contraction produced by veratrine or barium salts is abolished by potassium salts. They are direct muscular depressants, and depress also the nervous system, especially the brain and spinal cord, but very large doses are required to produce this effect.

Metabolism.—Much labour has been spent on the effect of alkalies on metabolism but they probably have more. If they have it is very slight.

Therapeutics of Potash.

External.—Caustic potash has been used to destroy lupus, and it was formerly employed to make issues. Care must be taken to limit its action, for it diffuses very rapidly. Liquor potassæ is used to dissolve off the fatty matters, and thoroughly cleanse the skin before operations, and weaker solutions of it are employed to remove the epidermis in certain chronic skin diseases. A 40-per-cent. solution is recommended to remove an in-growing toe nail, which is painted with the fluid, and in a few seconds is so softened that much can be scraped off. The procedure is repeated till the nail that remains is sufficiently thin to be removed with a pair of fine scissors. Dilute solutions, acting as sedatives, relieve itching.

Internal.—To obtain the effects of alkalies upon internal organs the bicarbonate, citrate, and acetate of potassium are preferable to potash, for that is apt to irritate the stomach, but it is occasionally used in small doses as a gastric sedative for dyspepsia.

Toxicology, see *Soda* (p. 144).

3. Potassii Carbonas.—Potassium Carbonate. K_2CO_3. *Synonym.*—Salt of tartar.

Source.—Obtained by the interaction of potassium sulphate and calcium carbonate.

Characters.—A white, very deliquescent, crystalline powder with a caustic taste, soluble in its own weight of water, insoluble in alcohol. Contains not less than 81·5 per cent. of pure potassium carbonate.

Twenty grains neutralize 17 *grains of citric acid or* 18 *grains of tartaric acid.*

Impurities.—Sulphates, chlorides.

It is used in preparing Liquor Arsenicalis (as a solvent), Decoctum Aloes Compositum (to dissolve the resin), and Mistura Ferri Composita (carbonate of iron is formed).

Dose, 5 to 20 gr.—3 to 12 decigrms.

Action and Therapeutics of Potassium Carbonate.

These are the same as those of potash, but the carbonate is less caustic.

4. Potassii Bicarbonas. — Potassium Bicarbonate. $KHCO_3$.

Source.—Pass carbonic anhydride through a strong aqueous solution of potassium carbonate, and let the bicarbonate crystallize out.

Characters.—Non-deliquescent, colourless monoclinic prisms. Taste mildly alkaline. *Solubility.*—1 in 4 of water.

Twenty grains neutralize 14 *grains of citric acid or* 15 *grains of tartaric acid.*

Impurity.—The carbonate.

Dose, 5 to 30 gr.—3 to 20 decigrms.

Action of Potassium Bicarbonate.

The potassium bicarbonate is too feebly caustic to be of any use as a caustic. Otherwise its actions are those of potash.

Therapeutics of Potassium Bicarbonate.

Stomach. — Potassium bicarbonate neutralising some of the gastric secretion is very useful when an excessive quantity of gastric juice is secreted. Often in these cases of hyperacidity there is pain and flatulence; both these are diminished by the bicarbonate taken after meals, but it is better treatment to remove the cause of the dyspepsia. It is not a common remedy for dyspepsia, bicarbonate of sodium being usually preferred. Either is beneficial when much mucus is present, for this is rendered less viscid by alkalies. It should not be used as an alkali in cases of poisoning by mineral acids, because of the evolution of carbonic acid gas. Bicarbonates are used in preference to carbonates, as the latter are far too strongly alkaline for the stomach. Potash water is often drunk as an effervescing water instead of soda water. It

should be a solution (30 gr. to the pint) of potassium bicarbonate in water into which CO_2 gas under a pressure of four atmospheres has been passed.

Pancreas.—Alkalies decrease the pancreatic secretion, for they inhibit the formation of gastric juice, and the pancreatic flow is excited by acids.

Blood. — Potassium bicarbonate circulates in the blood as such. It was formerly much used in rheumatic fever, but is now superseded by salicylates. Probably it did no good. In gout it is given to increase the alkalinity of the blood which contains an excess of uric acid and to diminish metabolism, but there is no evidence that it thus benefits gout, and the many alkaline mineral waters used for this disease are efficacious because they cause diuresis, thereby assisting the excretion of uric acid. Potassium bicarbonate is believed to be hæmatinic: that is to say, it is thought to increase the amount of hæmoglobin; but as for this purpose it is usually given with iron, its hæmatinic power has not yet been proved.

Kidneys.—It is not much used for its diuretic effect and its alkalizing power over the urine, as the vegetable salts are preferable.

5. Potassii Acetas.—Potassium Acetate. $KC_2H_3O_2$.

Source.—Obtained by fusing the product of the interaction of acetic acid and potassium carbonate. It contains not less than 90 per cent. of pure potassium acetate.

Characters.—White, foliated, very deliquescent, satiny, neutral masses or granular particles of peculiar odour. *Solubility.*—2 in 1 of water.

Impurities.—The carbonate and metallic impurities.

Dose, 15 to 60 gr.—1 to 4 grms.

6. Potassii Citras. — Potassium Citrate. $K_3C_6H_5O_7,H_2O$.

Source.—Neutralize potassium carbonate with a solution of citric acid, and evaporate to dryness.

Characters.—A white, deliquescent powder. Taste saline, feebly acid. *Solubility.*—10 in 6 of water.

Dose, 15 to 60 gr.—1 to 4 grms.

Action of Potassium Acetate and Citrate.

External.—No action. Being neutral they are not even antacid.

Internal.—These are the least irritating to the stomach of all potassium salts; being neutral they have no action on gastric juice. They circulate as the carbonate of potassium. Both are more powerfully diuretic than any other potassium salts, and act by directly stimulating the renal cells. They are diaphoretic, especially the citrate, but neither of them causes a great increase of the perspiration. How they produce this effect is not certainly known.

Therapeutics of Potassium Acetate and Citrate.

As neither impairs digestion, they are chiefly used for remote effects.

Blood.—They have been largely given for rheumatic fever, but are now rarely employed. Many believe both salts are of great value in gout; if that is so, as they do not increase the power of blood plasma to dissolve sodium biurate, they probably act as diuretics by washing out uric acid. They are reputed antiscorbutics, that is to say, preventers of scurvy; but they are not so efficacious as lemon juice, lime juice, and fresh vegetables.

Kidneys.—Although in health the diuresis produced by citrate and acetate of potassium is slight, and the urea and other solids of the urine are hardly altered, yet clinical experience shows that both are, in Bright's disease, diuretics. They are frequently used in this disease and in feverish conditions, and also to increase the amount of urine, and thus to remove pathological fluids in cases of pleuritic effusion, ascites, &c. Diuretics are best combined, and the following is a good mixture: Potassium acetate, 20 gr.

(12 decigrms.); tincture of squill, 10 ♏ (6 decimils); spirit of nitrous ether, 30 ♏ (18 decimils); Succus Scoparii, 1 fl. dr. (4 mils); water to 1 fl. oz. (30 mils).

They render the urine alkaline, and are much employed for this purpose, having the advantage over other potassium salts that they do not derange digestion. They are of use in tubal nephritis, for the urinary alkalies aid the expulsion of fatty casts. Not only do they retard the precipitation of uric acid, and thus hinder the formation of uric acid gravel, but perhaps they will dissolve minute uric acid calculi. To keep the urine at the alkalinity necessary for this purpose, 45 to 60 grains (3 to 4 grms.) of the acetate or citrate should be dissolved in four ounces (120 mils) of water, and taken every four hours. If more than this is used, harm is done, for an insoluble biurate forms on the surface of the calculus. With many patients it suffices if such a dose in a tumbler of water be taken at bed-time; for during the night the acidity of the urine is highest, as there is no alkaline tide due to meals. They relieve irritation in the bladder as they decrease the acidity of the urine and thus are much used for cystitis.

Skin.—Both these salts may be used in slight pyrexia, such as that of a common cold, on account of their diaphoretic properties.

Lungs.—These salts, like the carbonates and bicarbonates, are mild saline expectorants, especially suitable for cases of bronchitis, with viscid, scanty expectoration, as they increase the secretion and lessen the viscidity. The iodide of potassium is, however, still more efficacious.

7. Potassii Sulphas. — Potassium Sulphate K_2SO_4.

SOURCE.—Obtained by the interaction of sulphuric acid and potassium chloride or certain other potassium salts.

CHARACTERS.—Hard, colourless, rhombic prisms, terminated by six-sided pyramids. Taste, disagreeable. *Solubility.*—1 in 10 of water.

IMPURITIES.—Other sulphates and chlorides.

Dose, 15 to 45 gr.—1 to 3 grms.

It is contained in Pilula Colocynthidis Composita, 1 in 20, Pilula Colocynthidis et Hyoscyami, 1 in 32, Pilula Ipecacuanhæ cum Scilla, 1 in 2, Pulvis Ipecacuanhæ Compositus, 8 in 10 (in the last two merely as a diluent).

8. Potassii Tartras. — Potassium Tartrate. $(K_2C_4H_4O_6)_2H_2O$.

SOURCE.—Neutralize acid potassium tartrate with potassium carbonate.

CHARACTERS.—Small, colourless, deliquescent prisms. *Solubility.*—10 in 8 of water.

IMPURITIES.—Acid tartrate and carbonate of potassium.

Dose, 30 to 60 gr.—2 to 4 grms. (diuretic); **30 to 240 grs.—2 to 16 grms.** (purgative).

9. Potassii Tartras Acidus.—Acid Potassium Tartrate. $KHC_4H_4O_6$. *Synonyms.*—Bitartrate of potash; Cream of tartar.

SOURCE.—Obtained by purification from crude tartar (argol) deposited on the sides of wine casks during the fermentation of grape juice.

CHARACTERS.—A fine, white, gritty powder or pieces of a larger crystalline mass. Taste, pleasant, acid. *Solubility.*—1 in 200 of cold water.

IMPURITY.—Calcium tartrate.

Dose, 15 to 60 gr.—1 to 4 grms.

It is contained in Confectio Sulphuris, Pulvis Jalapæ Compositus, and Trochiscus Sulphuris.

ACTION OF POTASSIUM SULPHATE, TARTRATE, AND ACID TARTRATE.

External.—One of these being only slightly acid and the others neutral, they have none of the external caustic or antacid properties of other potassium salts.

Internal.—*Intestines.*—All three salts are typical hydragogue saline purges, producing easy, soft, watery motions without griping. Their mode of action has already been fully described (*see* p. 97).

Liver.—The sulphate of potassium is by some believed to be a moderate cholagogue, slightly increasing the biliary flow.

Kidneys.—The tartrate and acid tartrate are diuretics, because a small amount of them is, in the intestine, converted into a carbonate and absorbed, and this acts directly on the renal cells. Hence they render the urine alkaline. But all the sulphate and most of the tartrate and acid tartrate is excreted with the fæces, and if, as seems probable, some is absorbed by the small intestine in the form in which it is taken, it is excreted again into the colon.

Therapeutics of Potassium Sulphate, Tartrate, and Acid Tartrate.

Internal.—*Intestines.*—These excellent purgatives are frequently used, especially for habitual sluggishness of the bowels. A dose should be dissolved in a tumbler of warm water, and sipped during dressing. They may be employed to open the bowels in cases, such as dropsy or uræmia, in which we wish to eliminate as much fluid as possible. They should for this purpose be given in a concentrated form, for then a large amount of fluid will be poured from the intestine to bring the solution of the salt to that degree of dilution at which it will act. Compound jalap powder is also much used for this class of case. As sulphate of potassium may have some cholagogue action it is to be preferred when it is believed that the liver is at fault.

Liver.—These salts are often given to those who suffer from gall-stones, although no salts of potassium

have power to dissolve gall-stones, but the sulphate perhaps does good as an indirect cholagogue.

Kidneys.—The tartrate and acid tartrate are sometimes used as diuretics in the same class of case as the acetate and citrate. A very pleasant drink for feverish patients is Imperial drink. It contains acid potassium tartrate, 60 gr. (4 grms.); glusidum, 1 gr. (6 centigrms.); oil of lemon, 3 ♏ (18 centimils) to a pint of boiling water.

10. Potassii Nitras.—Potassium Nitrate. KNO_3.
Synonyms.—Nitre; Saltpetre.

SOURCE.—Obtained by the action of sodium nitrate and potassium chloride.

CHARACTERS.—White, striated, six-sided prisms. Taste, cool, saline. *Solubility.*—1 in 4 of water.

IMPURITIES.—Sulphates, chlorides, and lime.

Dose, 5 to 20 gr.—3 to 12 decigrms.

ACTION OF POTASSIUM NITRATE.

External.—Nothing noteworthy.

Internal.—*Stomach and Intestines.*—Nitrates are powerful irritants and depressants, and therefore potassium nitrate is liable to cause nausea, vomiting, diarrhœa, symptomatic of the gastritis and enteritis produced by it.

Blood.—Owing to its high diffusion power it quickly passes into the blood unchanged. External to the body, nitrates prevent the coagulation of the blood, or dissolve the clot if it be already formed, but it is not known that they have any effect on the blood in the body.

Heart.—Unlike other potassium salts the nitrate is a cardiac depressant, causing the beats to become feeble and few. Large doses lead to great weakness, fainting, and death.

Kidneys.—Small doses are diuretic from their direct action on the renal cells, but large ones are liable to inflame the urinary passages, causing

hæmaturia. The drug is excreted unchanged in the urine.

Skin.—Nitrate of potassium is a mild diaphoretic.

THERAPEUTICS OF POTASSIUM NITRATE.

Internal.—*Blood.*—On account of its supposed action in preventing the coagulation of the living blood, it has been used in rheumatic fever and many inflammatory conditions, but it is now discarded. Probably, as it is a cardiac depressant, it only does harm.

Kidneys and Skin.—It is sometimes employed as a diuretic and diaphoretic in febrile conditions, but the acetate and the citrate are much preferable.

Asthma.—For the treatment of this disease, blotting paper is soaked in a solution of nitre of about 50 gr. (3 grms.) to the fluid ounce (30 mils) of water; six pieces about $1\frac{1}{2}$ inch square are, when dry, successively placed in a jar and lighted one at a time. The patient inhales the fumes, the composition of which is not certainly known. Ringer considers it better to dip the paper also into a solution of chlorate of potash, and to burn a piece large enough to fill a whole room with the fumes. This treatment often relieves, and nitre is a common ingredient of asthma powders.

11. Potassii Chloras. — Potassium Chlorate. $KClO_3$.

SOURCE.—Pass chlorine into water holding lime or magnesia in suspension; treat the liquid with potassium chloride and crystallize the potassium chlorate.

CHARACTERS.—Colourless, monoclinic crystals. Taste, cool. *Solubility.*—1 in 16 of cold water.

INCOMPATIBLES.—Easily explodes on trituration with many substances, especially sugar, sulphur, tannin, charcoal, and glycerin.

IMPURITIES.—Calcium chloride and lime.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Preparation.

Trochiscus Potassii Chloratis. 0·2 grm. or 3 gr. in each with a rose basis.

Action of Potassium Chlorate.

External.—It is believed to be easily decomposed by septic tissues, and that the nascent oxygen given off acts as a stimulant and antiseptic to them.

Internal.—*Stomach and Intestines.*—Small doses have no effect; poisonous ones produce symptoms similar to those induced by the nitrate.

Blood.—Here also small doses have no effect, but several cases of poisoning show that in large doses chlorate of potassium disintegrates the red corpuscles, and converts hæmoglobin into methæmoglobin The altered blood, owing to loss of oxygen-carrying power, causes the skin to be cyanotic; it is passed by the urine, which is therefore dark-coloured, and contains granular *débris*, and thus the urine is exactly like that met with in paroxysmal hæmoglobinuria. The liver and spleen are enlarged. There may be jaundice and hæmatemèsis, and the marrow of the bones becomes very vascular. Nephritis is induced, the tubules are blocked by the *débris* of the blood, and so the urine is scanty. Death occurs from cardiac weakness or uræmia.

As potassium chlorate easily yields up its oxygen, formerly it was believed that it gave off part of its oxygen to the tissues while circulating in the blood, but much of it is excreted unchanged in the urine and other excretions.

Therapeutics of Potassium Chlorate.

It is used for stomatitis, tonsilitis, and pharyngitis of all varieties, either as lozenges, gargle (10 gr. (6 decigrms.) to 1 fl. oz. (30 mils) of water or decoction of cinchona), or given to be swallowed in solution, for it is then excreted by the saliva. Its therapeutic action, which has been thought to be due to nascent oxygen, is therefore always local. It is

especially valuable for ulcerative stomatitis. It has been given to women liable to miscarry.

12. Potassii Bichromas, *see* Chromium.

13. Potassii Permanganas, *see* Manganese.

14. Potassii Iodidum, *see* Iodine.

15. Potassii Bromidum, *see* Bromine.

16. Potassa Sulphurata, *see* Sulphur.

17. Sapo Mollis, soft soap, is Potassium Oleate, *see* Olive Oil.

SODIUM.

Symbol, Na. Atomic weight, 23. (Not official.)

The metal sodium as met with in commerce. It decomposes water, and must therefore be kept under naphtha.

CHARACTERS.—Well known.

The sodium ion has no physiological action, and therefore all sodium salts act either by salt action or by the action of the other ion.

1. Sodii Carbonas.—Sodium Carbonate. Na_2CO_3 $10H_2O$. *Synonym.*—Soda or washing soda.

SOURCE.—Obtained from sodium chloride by interaction with ammonium bicarbonate, ignition and subsequent crystallization.

CHARACTERS. — Large oblique rhombic crystals, transparent when fresh, but they soon effloresce, and become white on the surface. Taste, caustic. *Solubility.*—1 in 2 of cold water.

Twenty grains neutralize 9·8 *grains of citric acid or* 10·5 *grains of tartaric acid.*

IMPURITIES.—Sulphates and chlorides.

Dose, 5 to 30 gr.—3 to 20 decigrms.

2. Sodii Carbonas Exsiccatus.—Exsiccated Sodium Carbonate. Na_2CO_3. It is nearly anhydrous.

SOURCE.—Sodium carbonate is gently heated till losing water of crystallization it loses 63 per cent. of its weight.

CHARACTERS.—A dry white powder.

It is contained in Pilula Ferri (carbonate of iron is formed).

Dose, 3 to 10 gr.—2 to 6 decigrms.

Action and Therapeutics of Sodium Carbonate and Dried Carbonate.

The same as those of potash, except that they are less caustic.

3. Sodii Bicarbonas. — Sodium Bicarbonate. $NaHCO_3$.

Source.—Made from the carbonate in the same way as potassium bicarbonate is made. Or, by the interaction of sodium chloride and ammonium bicarbonate.

Characters.—A white powder or small monoclinic crystals. Slightly alkaline; not caustic. *Solubility.*—1 in 11 of cold water.

Twenty grains neutralize 16·7 *grains of citric acid or* 17·8 *grains of tartaric acid.*

Impurities.—The carbonate.

Incompatibles.—It is decomposed by acids and acid salts, *e.g.* bismuth subnitrate.

Dose, 5 to 30 gr.—3 to 20 decigrms.

Action of Sodium Bicarbonate.

Sodium salts are not, when locally applied, depressant to the cardiac, muscular, and nervous systems, and therefore are not locally poisonous like potassium salts. Sodium bicarbonate is more slowly absorbed than the potassium salt, but after absorption its action is the same.

Therapeutics of Sodium Bicarbonate.

External.—A lotion of 7 gr. (5 decigrms.) to 1 fl. oz. (30 mils) of water is employed as a sedative to relieve itching.

Internal.—*Stomach.*—Its use in disease is very similar to that of the corresponding salt of potassium, but on account of the two differences just mentioned it is much more frequently given. Hence it is a very

common ingredient of medicines designed to relieve dyspepsia, being taken some time after meals to neutralize excessive acidity in the cases in which the patient complains of pain, which is relieved by food and comes on about four hours after a meal, or of heartburn and acid eructations. Its value is also partly due to its sedative action on the gastric nerves, whereby it relieves gastric pain, and partly also to its power of liquefying tenacious mucus. A very favourite gastric sedative mixture consists of about 10 grains (6 decigrms.) of sodium bicarbonate, together with 10 grains (6 decigrms.) of bismuth carbonate, suspended in mucilage. A grain or two of sodium bicarbonate, with a grain of powdered rhubarb and some sugar, forms a common stomachic powder for children. Sodium bicarbonate and gentian are also often combined together in stomachic mixtures. Effervescing soda water (made the same way as potash water, p. 133) is a mild gastric sedative. In commerce these waters often contain neither potash nor soda, but even then the carbonic acid gas acts as a sedative.

Sodium bicarbonate is slowly absorbed, in comparison with potassium salts, and therefore is rarely used for any effects it may have after absorption. Large doses (15 to 500 grains, 10 to 33 grms. a day), however, are useful for diabetic coma and all forms of acidosis, in which they neutralize the excess of acids in the blood.

Toxicology.

Poisoning by caustic alkalies is very rare; usually it takes place either by potash, soda, pearlash (potassium carbonate), or soap lees (sodium carbonate). (Both the last are impure. They contain caustic soda or potash.)

Symptoms.—A caustic taste is experienced, and is quickly followed by symptoms of gastro-intestinal irritation, viz. burn-

ing heat in the throat, vomiting, diarrhœa, and abdominal pain, together with those of depression, viz. a feeble quick pulse, and a cold and clammy skin. Soon the lips, tongue, and throat become swollen, soft, and red. *Post-mortem appearances.*—The mucous membrane of the mouth, tongue, stomach, and œsophagus, and occasionally that of the larynx, is excoriated, dark, softened, and inflamed.

Treatment.—Wash out the stomach, or give emetics, as zinc sulphate, 20 gr. (12 decigrms.); or powdered ipecacuanha, 30 gr. (2 grms.); or copper sulphate, 5 gr. (3 decigrms.) in half a pint of tepid water; or vinum ipecacuanhæ, 1 fl. oz. (30 mils); or mustard, a tablespoonful in half a pint of tepid water; or common salt, 2 tablespoonfuls in half a pint of tepid water; or $\frac{1}{10}$ gr. (6 milligrms.) of apomorphine hydrochloride hypodermically. If none of these is handy, give plenty of warm water and tickle the back of the throat. Then give feeble acids, as vinegar, diluted lemon juice, dilute solution of citric acid, dilute acetic acid. Then demulcents, as oil, linseed tea, or water and white of egg.

4. Sodii Phosphas.—Sodium Phosphate. $Na_2HPO_4,12H_2O$.

Source.—Obtained by the interaction of sodium carbonate and the solution of acid calcium phosphate produced on mixing bone ash and sulphuric acid.

Characters.—Transparent, colourless, efflorescent rhombic prisms. Taste, mildly saline. *Solubility.*—1 in 7 of cold water.

Impurity.—Calcium phosphate.

Dose, 30 to 120 gr.—2 to 8 grms.—for repeated administration, **$\frac{1}{4}$ to $\frac{1}{2}$ oz.—10 to 16 grms.**—for single administration.

5. Sodii Phosphas Effervescens.—Effervescing Sodium Phosphate.

Source.—Dry 50 of sodium phosphate till it has lost 60 per cent. of its weight as water. Mix with it sodium bicarbonate, 50; tartaric acid, 27; citric acid, 18. Heat the mixture till it aggregates, and then stir till it assumes a granular form.

Characters.—White granules, which effervesce on the addition of water.

Dose, 60 to 120 gr.—4 to 8 grms.—for repeated administration, **$\frac{1}{4}$ to $\frac{1}{2}$ oz.—10 to 16 grms.**—for single administration, in 3 to 6 fl. oz. of water.

6. Sodii Sulphas. — Sodium Sulphate. Na_2SO_4, $10H_2O$. *Synonym.*—Glauber's salts.

SOURCE.—Obtained by the interaction of sodium chloride with sulphuric acid.

CHARACTERS.—Colourless, monoclinic transparent prisms, efflorescing on exposure to air. Neutral; taste, saline. *Solubility.*—1 in 3 of water.

IMPURITIES.—Salts of ammonium and iron.

Dose, 30 to 120 gr.—2 to 8 grms.—for repeated administration, ¼ to ½ **oz.—10 to 16 grms.**—for single administration.

7. Sodii Sulphas Effervescens.—Effervescing Sodium Sulphate.

SOURCE.—Dry 50 of sodium sulphate till it has lost 55 per cent. of its weight as water. Then mix with it sodium bicarbonate, 50; tartaric acid, 27; citric acid, 18. Heat the mixture till it aggregates, and then stir till it assumes a granular form.

CHARACTERS.—White granules, which effervesce on the addition of water.

Dose, 60 to 120 gr.—4 to 8 grms.—for repeated administration, ¼ to ½ **oz.—10 to 16 grms.**—for single administration in 3 to 6 fl. oz. of water.

8. Sodii et Potassii Tartras.—Sodium Potassium Tartrate. $NaKC_4H_4O_6,4H_2O$. *Synonyms.*—Tartrate of sodium and potassium, tartarated soda, Rochelle salt.

SOURCE.—Neutralize acid potassium tartrate with sodium carbonate.

CHARACTERS. — Large, colourless, neutral, trimetric prisms. Taste like common salt. *Solubility.*—1 in 1·5 of cold water.

IMPURITY.—Acid potassium tartrate.

Dose, 120 to 240 gr.—8 to 16 grms.

Preparation.

Pulvis Sodæ Tartaratæ Effervescens.—*Synonym.*—Seidlitz powder. Take tartarated soda 7·5 grms. and sodium bicarbonate 2·5 grms.; mix and wrap in blue paper. Tartaric acid 2·5 grms., wrapped in white paper.

Dose.—Dissolve the powder in the blue paper in nearly half a pint of cold or warm water, and then add that in the white paper, and drink while effervescing.

9. Sodii Citro-Tartras Effervescens.—Effervescent Sodium Citro-tartrate.

Source.—Mix sugar, 15, sodium bicarbonate, 51, citric acid, 18, and tartaric acid, 27. Heat the mixture till it aggregates and assumes a granular form.

Characters.—White deliquescent granules, which effervesce on the addition of water.

Dose, 60 to 120 gr.—4 to 8 grms.—in 3 to 6 fl. oz. of water.

Action of Sodium Phosphate, Sulphate, Citro-Tartrate, and Tartarated Soda.

Internal.—*Intestines.*—Owing to the slowness with which, compared with the corresponding potassium salts, these sodium salts are absorbed, they pass on into the intestine and there act more efficiently than potassium salts. They are typical saline purgatives, producing a soft motion about two or three hours after administration (*see* p. 97).

The sulphate, which is the most active purgative, and the phosphate are said to be cholagogues, and Carlsbad waters (*see* p. 148) have been shown to increase in the human subject the amount of bile and the solids in it.

Blood and Kidneys.—Owing to their tardy absorption the action of these salines, as alkalizers of the urine, and as diuretics, is more feeble than that of the corresponding potassium salts.

Therapeutics of Sodium Phosphate, Sulphate, Citro-Tartrate, and Tartarated Soda.

Internal.—*Intestines.*—These salts of sodium are some of the best purgatives we possess, being especially useful for habitual constipation, and for constipation associated with gout, with hepatic dyspepsia, or with any of the manifestations of an excess of uric acid in the blood or the urine. The best way to take them is to dissolve the required amount in half a tumbler of lukewarm water, and to drink it in successive small draughts while dressing in the

morning. The bowels are then usually comfortably opened soon after breakfast. These salts, especially the phosphate and sulphate, are perhaps cholagogues; these two are therefore to be preferred in cases of gall-stones and disease of the liver. The sulphate is the most powerful purgative of all. It is the chief constituent of Carlsbad, Marienbad, Tarasp, and Condal waters, and it occurs associated with much sulphate of magnesium in Æsculap, Hunyadi János, Seidlitz, Pullna, Friedrichshall, Rubinat, Apenta, and Kissingen waters. A powder consisting of 30 grains (2 grms.) of each of sodium sulphate and magnesium sulphate, and a grain of each of sodium chloride and sodium bicarbonate (dose 60 to 240 grs., 4 to 16 grms.), forms when dissolved a good imitation of Æsculap, Hunyadi János, and Franz Josef waters. The phosphate is a milder and less unpleasant purgative than the others; it is often given to children. The effervescing preparations are palatable forms.

Large doses make the evacuations very watery, and are useful to remove fluid in dropsy or ascites (especially if due to disease of the liver). Sufferers from gallstones are undoubtedly benefited by a course of waters containing sulphate of sodium, and therefore go to Carlsbad. Two hourly doses of 120 grs. of sodium sulphate are excellent for bacillary dysentery.

10. Sodii Chloridum.—Sodium Chloride. NaCl. *Synonym.*—Common salt.

SOURCE.—Obtained by purifying common salt.

CHARACTERS.—Small, white, crystalline grains or transparent cubic crystals. *Solubility.*—1 in 3 of cold water.

ACTION OF SODIUM CHLORIDE.

Common salt forms an article of diet with all creatures living on vegetable food, especially if it contains large amounts of potassium, but is not used either by carnivorous animals or by tribes living solely

on flesh. The importance of it is seen in the long distances herbivorous animals will wander to salt-licks, and by the fact that tribes living on vegetables will go to war for the possession of it. Bunge's explanation of this desire for salt is as follows: Blood plasma contains much sodium chloride, vegetable foods contain a large amount of potassium salts; when, therefore, these salts of potassium reach the blood, potassium chloride and the sodium salt of the acid which was combined with the potassium are formed. This and the potassium chloride are excreted by the kidneys, and the blood loses its sodium chloride, which loss is therefore made up by taking sodium chloride with the food. The deprival of salt leads to general weakness, œdema, and anæmia, a series of symptoms often seen in France before the repeal of the salt tax.

Quantities of a tablespoonful and upwards act as an emetic, and may also purge, for the hypertonic solution withdraws fluid from the gastro-intestinal mucous membrane, and so acts as an irritant. Rectal injections of solutions of salt are used as an anthelmintic for the *Oxyuris vermicularis*.

Therapeutics of Sodium Chloride.

It is occasionally used as an emetic, also as an anthelmintic. Bathing in sea water acts as a mild general stimulant, and very concentrated hot salt baths, such as those of Droitwich and Nantwich, are useful for chronic rheumatism and sciatica. Eighty grains of common salt (0·91 per cent. is isotonic with the blood) in a pint of boiled water allowed to cool to 100° F. (38·5° C.) form a normal saline solution, which is frequently injected in cases of collapse in which the fluid in the blood-vessels is lessened, as from hæmorrhage, vomiting, or diarrhœa, often with strikingly good results. A pint or rather more is a usual quantity to employ for an adult. It may be

injected into the rectum, under the skin, or into a vein, according to the urgency. Such injections have also been used for diabetic coma, and may render the patient sensible again for a little while as they dilute the excess of poison in the blood. There is an excess of salt in the fluids of œdematous parts, therefore some order a salt-free diet in the hope that fluid will pass from the œdematous part into the vessels and so be eliminated by the kidneys.

11. Sodii Sulphis. — Sodium Sulphite. Na_2SO_3, $7H_2O$.

SOURCE.—Saturate a solution of sodium carbonate with sulphurous acid gas.

CHARACTERS.—Colourless, transparent, monoclinic prisms. Contains not less than 94 per cent. of pure sodium sulphite. *Solubility*.—1 in 2 of water.

Dose, 5 to 20 gr.—3 to 12 decigrms.

ACTION AND THERAPEUTICS OF SODIUM SULPHITE.

Sodium sulphite solutions (1 in 8) may be used externally as mild antiparasitics. In the stomach it is decomposed by the acids, and gives off sulphurous anhydride. It may therefore be given to arrest fermentation. If any remains undecomposed it is absorbed as a sulphite. No other action of this salt is known.

12. Acid Sodium Phosphate.—*Synonyms*.—Sodium di-hydrogen phosphate; Sodium biphosphate. It contains not less than 70 per cent. of pure sodium di-hydrogen phosphate, NaH_2PO_4.

CHARACTERS.—Transparent, colourless, rhombic crystals, or in crystalline powder. Taste saline acid. Readily soluble in water, the solution being acid to litmus.

Dose, 30 to 60 gr.—2 to 4 grms.

ACTION AND THERAPEUTICS.

This salt is the cause of the natural acidity of the urine, and given internally in doses of 30 gr.

(2 grms.) in water every hour, it increases the acidity of the urine and is very useful when that fluid is alkaline from decomposition in the urinary tract.

13. Sodii Citras.—Sodium Citrate. (Not official.) Much of the indigestion that follows giving cow's milk to infants is owing to the fact that the curds of cow's milk formed in the stomach are very dense. The density is proportionate to the amount of calcium in the milk. If citrate of sodium is added, calcium citrate is formed and the curds are much less dense. It is found that if to each ounce of cow's milk a drachm of water containing a grain of sodium citrate is added, the curds are not dense, the indigestion is relieved, and the absorption of sufficient calcium from the milk is not prevented. Judging by clinical experience sodium citrate thus given certainly seems beneficial, but it has been stated that although outside the body it lessens the curdling of milk, it does not do so in the presence of the gastric juice. The same treatment may be applied to the milk given to those suffering from typhoid fever, for here also dense curds are troublesome.

14. Sodii Bromidum, *see* Bromine.
15. Sodii Iodidum, *see* Iodine.
16. Sodii Hypophosphis, *see* Phosphorus.
17. Sodii Arsenas Anhydrosus, *see* Arsenic.
18. Liquor Sodæ Chlorinatæ, *see* Chlorine.
19. Sodii Nitris, *see* Nitrites.
20. Sodii Benzoas, *see* Acidum Benzoicum.
21. Sodii Salicylas, *see* Acidum Salicylicum.
22. Borax, Sodium Biborate, *see* Acidum Boricum.
23. Sapo Durus, Hard Soap, is Sodium Oleate.
24. Sapo Animalis, Curd Soap, is chiefly Sodium Stearate.

AMMONIUM.

Symbol, NH_4. (Not official.)

1. Liquor Ammoniæ Fortis.—Strong Solution of Ammonia. NH_3 (32·5 per cent. dissolved in water).

SOURCE.—Generate ammonia gas by heating ammonium chloride with slaked lime, and pass it into water.

CHARACTERS.—A colourless liquid, of a very pungent odour, and very alkaline. Sp. gr. 0·888.

IMPURITIES.—Ammonium chloride, sulphide, and sulphate, pyridine and other compound ammonias.

Preparations.

1. **Linimentum Camphoræ Ammoniatum.**—*Synonym.*—Compound liniment of camphor.—Liquor Ammoniæ Fortis, 250; camphor, 125; oil of lavender, 5; alcohol (90 per cent.) to make 1000 parts.

2. **Linimentum Hydrargyri**, *see* Mercury.

3. **Spiritus Ammoniæ Aromaticus**, *see* Ammonium Carbonate.

4. **Spiritus Ammoniæ Fetidus**, *see* Asafetida.

5. **Tinctura Guaiaci Ammoniata**, *see* Guaiacum.

2. Liquor Ammoniæ.—Solution of Ammonia. NH_3 (10 per cent. dissolved in water).

SOURCE.—Mix strong solution of ammonia, 1 part, and distilled water, 2 parts.

CHARACTERS.—Like but less pungent than the strong solution. Sp. gr. 0·959.

Preparations.

1. **Linimentum Ammoniæ.**—Liquor Ammoniæ, 1; almond oil, 1; olive oil, 2. Ammonia soap or oleate of ammonium is formed.

2. **Tinctura Ergotæ Ammoniata**, *see* Ergot.

3. **Tinctura Opii Ammoniata**, *see* Opium.

4. **Tinctura Quininæ Ammoniata**, *see* Quinine.

5. **Tinctura Valerianæ Ammoniata**, *see* Valerian.

6. **Tinctura Valerianæ Indicæ Ammoniata**, *see* Indian Valerian.

ACTION OF SOLUTIONS OF AMMONIA.

External.—A solution of ammonia produces rubefaction with a sensation of heat, and, if strong, a sensation of pain and burning. If the vapour is confined it causes vesication.

Internal.—*Nose.*—When inhaled, the vapour of ammonia is irritating to the nose and air passages, causing a pungent sensation and sneezing. The eyes and nose water. The pulse and respiration are reflexly accelerated. If very concentrated it produces swelling and inflammation of the nose, glottis, and respiratory tract.

Stomach.—As an alkali ammonia acts like other alkalies (*see* potassium bicarbonate). It dilates the gastric vessels, and produces a feeling of warmth in the epigastrium. It reflexly stimulates the heart and respiration.

Blood.—Its action on the blood is not known.

Heart.—Ammonia causes a rise of blood-pressure from contraction of the arterioles following stimulation of the vaso-motor centre. Usually there is an increased pulse rate, due probably to stimulation of the accelerator mechanism.

Respiration.—It increases greatly the frequency of respiration, probably from stimulation of the respiratory centre in the medulla.

Nervous system.—The brain is unaffected, and the nerves also, except for the tingling produced when a strong solution of ammonia is locally applied. Convulsions are often produced in animals poisoned by ammonia; these are due to stimulation of the spinal cord. The effects described under heart, respiration, and nervous system are only seen in animals and when the drug is injected subcutaneously or intravenously.

Kidneys.—Ammonia and ammonium carbonate are converted by the liver to urea, which is excreted by the kidneys. Ammonium salts of mineral acids such as the chloride are excreted unchanged. Organic salts such as the citrate and acetate are partly converted to urea, the acid radicle being oxidized to carbonic acid, partly excreted unchanged.

Therapeutics of Solutions of Ammonia.

External.—The two liniments are used as counter-irritants in numerous conditions, such as chronic joint disease and chronic rheumatism, and they are often rubbed on the chest in bronchitis. Ammonia is a very uncertain vesicant. Weak solutions of it are often applied to the bites produced by insects. Liquor ammoniæ is very valuable when held to the nose of any one who has fainted, for it almost instantly reflexly produces its stimulating effect on the heart and respiration.

Internal.—Ammonia in some form may be given before meals as a gastric stimulant in dyspepsia. Sal volatile is often used for this purpose, and also for its general stimulating effect on the cardiac, respiratory, and spinal systems, especially in sudden collapse from any cause. Ammonia has been injected subcutaneously in cases of snake-bite.

3. Ammonii Carbonas.—Ammonium Carbonate. A variable mixture of ammonium hydrogen carbonate NH_4HCO_3, with ammonium carbamate $NH_4NH_2CO_2$.

Source.—Heat ammonium sulphate or chloride with calcium carbonate.

Characters.—Translucent crystalline masses, volatile, and pungent to the smell. *Solubility.*—1 in 4 of water.

Twenty grains neutralize $26\frac{3}{4}$ *grains of citric acid or* $28\frac{3}{4}$ *grains of tartaric acid.*

Impurities.—Sulphates and chlorides.

Dose, 3 to 10 gr.—2 to 6 decigrms.

Preparation.

Spiritus Ammoniæ Aromaticus. *Synonym.*—Spirit of sal volatile. Ammonium carbonate, 100; Liquor Ammoniæ Fortis, 200; oil of nutmeg, 15; oil of lemon, 20; alcohol (90 per cent.), 3000; water, 1500. Mix the oils with the alcohol and water. Distil. To the last portion of the distillate add the ammonia and the carbonate. Heat till solution takes place, and

then add to the first portion of the distillate. Sp. gr. 0·888 to 0·893.

It contains in alcoholic solution normal ammonium carbonate, $(NH_4)_2CO_3$, with a large excess of ammonium hydroxide.

Dose, 20 to 40 m.—12 to 25 decimils—for repeated, **60 to 90 m.—4 to 6 mils**—for single administration.

Action and Therapeutics of Ammonium Carbonate.

The external and internal actions of the carbonate are the same as those of Liquor Ammoniæ. It is not used externally, but Spiritus Ammoniæ Aromaticus is inhaled for its reflex effects, is taken as a gastric stimulant and carminative in dyspepsia, and as a reflex cardiac and general stimulant in syncope. The carbonate is, in addition, an excellent expectorant, increasing the flow of bronchial secretion, stimulating the respiratory movements, and aiding the expulsion of thick mucus. It is most used for bronchitis in children and the aged. It is an emetic acting directly on the stomach.

Toxicology.

Liquor ammoniæ and the carbonate produce symptoms like other alkalies, but are more corrosive. The air-passages are often inflamed, and the inhalation of the vapour has been known to kill from this cause.

Treatment as for other alkalies (*see* p. 145).

4. Ammonii Chloridum.—Ammonium Chloride. NH_4Cl. *Synonym.*—Sal ammoniac

Source.—May be formed by neutralizing a crude solution of ammonia or ammonium carbonate with hydrochloric acid.

Characters.—Colourless crystals, volatile. *Solubility.*—1 in 3 of water.

Impurities.—Chiefly tarry matters.

Dose, 5 to 20 gr.—3 to 12 decigrms.

Action of Ammonium Chloride.

Locally applied ammonium chloride increases the secretion of mucous membranes, and to a slight extent it does the same after absorption. It is said to be a feeble cholagogue, diaphoretic, and diuretic. In large doses it has the same action on the heart, respiration, and nervous system as ammonia.

Therapeutics of Ammonium Chloride.

It is a very favourite remedy for local application, by means of inhalation of the vapour, to increase the secretion of mucus from the pharynx, Eustachian tubes, larynx, trachea, and bronchi in cases of chronic pharyngitis, otitis media, laryngitis, and bronchitis. Many forms of apparatus for its inhalation are in the market. In most of them it is generated by the action of hydrochloric acid on ammonia. It is occasionally given by the mouth either as a cholagogue, gastric stimulant, diaphoretic, or diuretic, but it is too feeble to be recommended, and it is very nasty; the taste may to some extent be concealed by liquorice. It is sometimes useful in chronic bronchitis with much expectoration, and is then best given as a lozenge. Some authorities consider it a specific for neuralgia. It is not a general stimulant.

5. Liquor Ammonii Acetatis.—Solution of Ammonium Acetate. *Synonym.*—Minderer's spirit.

Source.—Ammonium carbonate, 50; acetic acid, 162·5; water to 1000.

Incompatibles.—Potash, soda, and their carbonates, acids, lime water, salts of lead and silver. Should be preserved in green glass bottles.

Dose 2 to 6 fl. dr.—8 to 24 mils.

6. Liquor Ammonii Citratis.—Solution of Ammonium Citrate.

SOURCE.—Dissolve 125 of citric acid in 625 of water, neutralize with ammonium carbonate 87·5, and add water to make 1000. Preserve in green glass bottles.

Dose, 2 to 6 fl. dr.—8 to 24 mils.

ACTION AND THERAPEUTICS OF THE AMMONIUM ACETATE AND CITRATE.

These are mild diaphoretics and diuretics and are used only for these effects. They probably act in both cases either on the secretory cells or the nerves connected with them. They do not irritate the kidneys, but increase both the water and the solids excreted. They are employed in Bright's disease as diuretics, and in febrile conditions as diaphoretics.

7. Ammonii Benzoas, *see* Acidum Benzoicum.

8. Ammonii Bromidum, *see* Bromine.

LITHIUM.

Symbol, Li. Atomic weight, 6·94. (Not official.)

1. Lithii Carbonas.—Lithium Carbonate. Li_2CO_3.

SOURCE.—Obtained from native lithium silicates.

CHARACTERS.—A white powder, or minute crystalline grains; alkaline. *Solubility.*—1 in 80 of water.

IMPURITIES.—Lime, alumina.

Dose, 2 to 5 gr.—12 to 30 centigrms.

2. Lithii Citras. — Lithium Citrate. $C_3H_4{\cdot}OH(COOLi)_3 4H_2O$.

SOURCE.—Act on lithium carbonate with citric acid.

CHARACTERS.—White, crystalline powder. *Solubility.*—1 in 2 of water.

Dose, 5 to 10 gr.—3 to 6 decigrms.

3. Lithii Citras Effervescens.—Effervescent Lithium Citrate.

SOURCE.—Mix 210 of citric acid and 50 of lithium citrate, add 310 of tartaric acid and 580 of sodium bicarbonate. Triturate, heat at 100°C., when granular dry at 55°C.

Dose, 60 to 120 gr.—4 to 8 grms.

Action of Lithium Salts.

The official lithium salts are converted into a chloride in the stomach, and if given too concentrated, or in too large doses, cause vomiting and diarrhœa, due to gastro-enteritis, which is the cause of death in animals poisoned by lithium. The gastro-enteritis occurs also if lithium is given subcutaneously, the drug being then partly excreted by the gastro-intestinal mucous membrane. However given it is excreted chiefly by the urine, and to a less extent by the saliva. These lithium salts render the urine alkaline, and are in virtue of their salt action diuretic. Lithium biurate is readily soluble, but is only formed from concentrated solutions of lithium salts, and hence they are useless as solvents of uric acid in man. They are general depressants to muscular tissue, but in this respect they are much less powerful than potassium salts.

Therapeutics of Lithium Salts.

A lotion of the carbonate of lithium (4 gr., 25 centigrms., to 1 fl. oz., 30 mils, of water) has been applied externally on lint covered with gutta percha to relieve the pain of gouty inflammation, to promote the healing of gouty ulcers, and to aid the disappearance of tophi, but any benefit that may follow is due to the warmth of the application, and not to a solvent action of the lithium salt upon the uric acid, for lithium salts cannot be absorbed through the skin. Salts of lithium have been much given to patients suffering from acute or chronic gout, uric acid calculus, or gravel, but in the body they must be too dilute to be of any use as a solvent of uric acid, and any improvement that follows their employment might equally well be obtained by distilled water. It has been shown that the addition of medicinal

doses of lithium salts to blood serum does not increase the solubility of uric acid in it. Lithium salts should always be freely diluted. The citrate has the advantage of greater solubility. Lithium salicylate (dose, 7 to 15 grains, ½ to 1 grm.) is recommended, as salicylic acid increases the excretion of uric acid.

GROUP III.

METALS OF THE ALKALINE EARTHS AND THEIR ALLIES.

Calcium, Barium, Strontium, Magnesium.

Of these Calcium, Barium, and Strontium are metals of the alkaline earths, and Magnesium was formerly included among them.

CALCIUM.

Symbol, Ca. Atomic weight, 40·07. (Not official.)
Calcium Carbonate is pharmacopœial in two forms.

1. Creta Præparata.—Prepared Chalk. $CaCO_3$.

Source.—Native calcium carbonate freed from most of its impurities by elutriation and drying.

Characters.—White friable pieces or a dull white powder. Insoluble in water.

Incompatibles.—Acids and sulphates.

Dose, 15 to 60 gr.—1 to 4 grms.

Preparations.

1. **Hydrargyrum cum Cretâ,** *see* Hydrargyrum.

2. **Mistura Cretæ.**—Prepared chalk, 30; tragacanth, 5; sugar, 60; cinnamon water, 1000.

Dose, ½ to 1 fl. oz.—15 to 30 mils.

3. **Pulvis Cretæ Aromaticus.**—Prepared chalk, 25; cinnamon, 10; cloves, 4; cardamom seeds, 3; nutmeg, 8; sugar, 50.

Dose, 10 to 60 gr.—6 to 40 decigrms.

4. **Pulvis Cretæ Aromaticus cum Opio,** *see* Opium.

2. Calcii Carbonas Præcipitatus.—Precipitated Calcium Carbonate. $CaCO_3$. *Synonym.*—Precipitated chalk.

SOURCE.—Boil together solutions of calcium chloride and sodium carbonate.

CHARACTERS.—A white crystalline powder insoluble in water.

IMPURITIES.—Chlorides, alumina, and iron.

INCOMPATIBLES.—Acids and sulphates.

Dose, 15 to 60 gr.—1 to 4 grms.

Contained in Trochiscus Bismuthi Compositus.

ACTION OF CALCIUM CARBONATE.

External.—It is mildly astringent and helps to dry moist surfaces.

Internal.—*Stomach and Intestines.* — Calcium carbonate is antacid. It is a mild but certain astringent. How it acts as an astringent is unknown. Very nearly all of any calcium salt is excreted unchanged in the fæces.

Absorption.—When calcium salts are taken, small quantities are absorbed; most of that absorbed is excreted by the epithelium of the large intestine, the rest by the kidneys. Calcium is necessary for all forms of protoplasm, thus many lowly organisms die when placed in water from which it is absent.

Kidneys.—Because certain mineral waters containing bicarbonates and sulphate of calcium, amongst other salts, have been used successfully in cases of urinary gravel and calculi, it has been asserted that these salts are diuretic, and solvent for uric acid, but it is more likely that the beneficial effects of these waters are due merely to the large amount of water drunk; anyhow, there is no proof that it is due to the salts. Such waters are those of Contrexéville and Vittel.

THERAPEUTICS OF CALCIUM CARBONATE.

External.—Prepared chalk forms an excellent dusting powder for moist eczema.

Internal.—*Alimentary canal.*—Because of its

mechanical action it is a good tooth powder. The following is a good formula: Potassium chlorate, 40 gr. (24 decigrms.); powdered hard soap, 80 gr. (48 decigrms.); carbolic acid, 20 gr. (12 decigrms.); oil of cinnamon, 10 ℳ (6 decimils); precipitated calcium carbonate to 1 oz. (30 grms.). Mistura Cretæ and Pulvis Cretæ Aromaticus, particularly the former, are very valuable for checking mild diarrhœa, especially in children.

Kidneys.—There is no doubt that persons passing gravel or urinary calculi, especially if composed of uric acid, are benefited by drinking the waters of Contrexéville and Vittel. They should be taken in quantities of 3 to 6 pints a day and between meals, to avoid the large amount of fluid causing indigestion. At Contrexéville the great bulk is drunk before breakfast.

3. Calx.—Lime. Calcium oxide. CaO.

SOURCE.—Made by calcining marble.

CHARACTERS.—Compact masses of a whitish colour which readily absorb water, and then swell and crack, with great evolution of heat, and fall into a powder (slaked lime).

4. Calcii Hydras.—Calcium Hydroxide. *Synonym.*—Slaked Lime. $Ca(OH)_2$.

SOURCE.—Prepared by the interaction of water and calcium oxide.

CHARACTERS.—A white, strongly alkaline powder. *Solubility.*—1 in 900 of cold water; if sugar be added 1 in 60.

IMPURITIES.—Those of the lime, viz. iron, alumen, silica.

INCOMPATIBLES.—Acids, metallic salts, tartar emetic.

Preparations.

1. **Liquor Calcis.** *Synonyms.*—Aqua calcis, Lime water. Shake up washed calcium hydroxide 50 in distilled water 5000, and siphon off. To be kept in green glass bottles. *Strength,* 0·1 per cent., $\frac{1}{10}$ gr. in 110 ℳ; 0·1 grm. in 100 millilitres.

Dose, 1 to 4 fl. oz.—30 to 120 mils.

2. **Liquor Calcis Saccharatus.**—Shake up calcium hydroxide 50 and sugar 100 in water 1000,

and siphon off. Is a solution of calcium saccharosate. To be kept in green glass bottles. *Strength*, 2 per cent., 2 gr. in 110 m; 2 grm. in 100 millilitres.

Dose, 20 to 60 m.—1 to 4 mils.

3. Linimentum Calcis.—Equal parts of lime water and olive oil. Lime soap or calcium oleate is formed.

Carron oil is composed of equal parts of lime water and linseed oil.

Liquor calcis is used in preparing Lotio Hydrargyri Flava, and Lotio Hydrargyri Nigra.

Action of Lime and Slaked Lime.

External.—Slaked lime is caustic. Lime water is astringent.

Internal.—*Alimentary tract.*—Lime is antacid. It prevents milk from forming solid bulky curds in the stomach. It allays vomiting, and is an antidote for poisoning by mineral acids, oxalic acid, and zinc chloride. It acts as a mild intestinal astringent.

Therapeutics.

External.—Slaked lime, employed as a caustic, is usually mixed with caustic potash, when it forms Vienna paste, used to destroy warts and other small growths. Lime water applied to weeping eczema is especially serviceable if mixed with glycerin. Linimentum Calcis is very valuable for burns.

Internal.—Lime water is much used to mix with milk to prevent its forming thick curds in the stomach, especially when, as is often the case with children, the curds cause vomiting. It is difficult to understand how it acts, for although lime water contains so little lime it is often efficacious. In severe cases of infantile vomiting, equal parts of milk and lime water may be ordered. If it is undesirable to dilute the milk so much, the saccharated lime water is an excellent preparation. Lime water will check

slight diarrhœa. It is a useful injection for thread-worms, for leucorrhœa, and for gleet.

5. Calcii Phosphas. — Calcium Phosphate. $Ca_3(PO_4)_2$. *Synonym.*—Phosphate of lime.

SOURCE.—May be made by the interaction of calcium chloride with sodium phosphate and excess of ammonia at a boiling temperature.

CHARACTERS.—A light white amorphous powder, insoluble in water.

Dose, 5 to 15 gr.—3 to 10 decigrms.

It is contained as a diluent in Pulvis Antimonialis and Extractum Euonymi.

Preparation.

Syrupus Calcii Lactophosphatis.—Calcium lactate, 75; concentrated phosphoric acid, 45; refined sugar, 700; orange flower water of commerce undiluted, 25; distilled water to make 1000. Contains calcium phosphate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTICS OF CALCIUM PHOSPHATE.

Calcium phosphate is a most important constituent of bones, and therefore it is necessary that food should contain it. If not the bones become soft. Calcium salts are abundant in milk, yolk of egg, vegetables, and the bones that carnivora eat. They are sparingly absorbed from the intestine, and mostly re-excreted into the intestine and passed with the fæces which also contain a large amount which has not been absorbed.

Calcium phosphate has been given for rickets, and for the anæmia and feebleness often seen in young children, but it is not certain that it does any good; nor indeed is it likely to, for in rickets the defect is not a lack of calcium salts, but an inability of growing bone to use them. It may be given to pregnant and suckling women in order to provide the child with sufficient calcium salts for its bones.

It is used as a diluent for powders, as it is inert and it prevents their agglutination. For these reasons, and because it is insoluble, it is a useful constituent of pills containing essential oils.

The Syrupus Calcii Lactophosphatis is with many a favourite preparation for phthisis and other conditions of anæmia and weakness.

6. Calx Sulphurata.—Sulphurated Lime. A mixture containing much calcium sulphate, some carbon, and not less than 50 per cent. of calcium sulphide, CaS.

SOURCE.—Obtained by heating a mixture of calcium sulphate and wood charcoal.

CHARACTERS.—A grey white powder, with a peculiar smell.

Dose, ¼ to 1 gr. in a pill—**16 to 60 milligrms.**

THERAPEUTICS OF CALX SULPHURATA.

It has been given internally in cases of suppuration, but it probably has no influence on the process. Lately it has been used for various glandular enlargements, and also for inflammatory processes induced by influenza.

7. Calcii Chloridum. — Calcium Chloride. $CaCl_2$.

SOURCE.—Obtained by neutralizing hydrochloric acid with calcium carbonate and evaporating.

CHARACTERS.—White masses, having a great affinity for water, and so deliquescent that they cannot be easily weighed. The drug should be kept in solution. Soluble in its own weight of water.

Dose, 5 to 15 gr.—3 to 10 decigrms.

8. Calcii Lactas.—Calcium lactate, $Ca(C_3H_5O_3)_2$, $5H_2O$.

SOURCE.—Obtained by neutralizing dilute lactic acid with calcium carbonate and evaporating.

CHARACTERS. — A white powder; almost tasteless. Soluble in 18·5 parts of water.

Dose, 10 to 30 gr.—6 to 20 decigrms.

Therapeutics of Calcium Chloride and Lactate.

Calcium salts increase the rate of coagulation of the blood, and they have therefore been recommended for hæmoptysis, hæmophilia, and other forms of hæmorrhage, and also for aneurysm, but as calcium is not absorbed from the intestine 2 gr. of calcium chloride in water, injected intramuscularly, should be given for a dose. Because jaundiced patients often bleed profusely, the same injection is given before operation on them to increase the coagulability of their blood. Calcium salts have been recommended for chilblains.

9. Calx Chlorinata, *see* Chlorine.
10. Calcii Hypophosphis, *see* Phosphorus.

BARIUM.

Symbol, Ba. Atomic weight, 137·3. (Not official.)

Barii Chloridum.—Barium Chloride. $BaCl_2,2H_2O$.

Characters.—Colourless, translucent tables.

It is in the Appendix of the Pharmacopœia, as an aqueous solution, used for testing, but it may be given internally.

Dose, ½ to 2 gr.—3 to 12 centigrms.

Action.

Barium salts cause the cardiac contractions to become slower and more forcible, acting like digitalis. The blood-vessels all over the body, including those of the lungs, are constricted by direct action on their muscle, and blood-pressure rises; the bronchioles too are constricted. The plain muscular fibres of the intestine may be excited, and then peristalsis being increased diarrhœa ensues. In these respects barium resembles ergot as well as digitalis. It acts like veratrine when applied locally to voluntary muscles, prolonging the contraction; but this effect is done away with by the application of potassium salts.

Therapeutics.

Barium chloride is not often given, but it has been used for mitral insufficiency accompanied by irregularity of the

heart, for hæmorrhage, and as a stimulant in atony of the bladder or intestine. Formerly it was given in nervous diseases. The waters of Llangammarch wells contain 6·7 grains per gallon of barium chloride, and have been used in cardiac cases.

Barium Sulphide (Not official), from ½ to 3 parts, with wheat starch 3 parts, made into a cream with water, spread on the skin, left for five or ten minutes, and then removed with a blunt knife, forms a good depilatory.

TOXICOLOGY.

Poisonous doses of barium salts cause salivation, thirst, vomiting, purging, difficulty of breathing, a slow pulse, and, from their ultimate action on the spinal cord, paralysis of the limbs. The heart is arrested in systole.

MAGNESIUM.

Symbol, Mg. Atomic weight, 24·32. (Not official.)

1. Magnesii Sulphas. — Magnesium Sulphate. $MgSO_4,7H_2O$. *Synonym.*—Epsom salts.

SOURCE.—It may be obtained from dolomite (native carbonate of calcium and magnesium), or magnesite (native magnesium carbonate), by the action of sulphuric acid, or by purifying the native sulphate.

CHARACTERS.—Minute colourless rhombic prisms very like zinc sulphate, but moister, and of a bitter taste, whilst that of the zinc salt is metallic. *Solubility.*—1 in 1 of cold water.

INCOMPATIBLES.—Alkaline carbonates, phosphoric acid, phosphates, lime water, lead acetate, and silver nitrate.

IMPURITIES.—Lime and iron.

Dose, 30 to 90 gr.—2 to 6 grms.—for repeated administration, **¼ to ½ oz.—8 to 16 grms.**—for single ad ministration.

Preparation.

Mistura Sennæ Composita. — Magnesium sulphate, 1 oz. in 4 fl. oz. *See* Senna.

2. Magnesii Sulphas Effervescens.—Effervescing Magnesium Sulphate.

SOURCE.—Dry 500 of magnesium sulphate till it has lost 23 per cent. of its weight. Then mix with it sodium

bicarbonate, 360; tartaric acid, 190; citric acid, 125; refined sugar, 105. Heat the mixture till it aggregates, and stir till it assumes a granular form.

CHARACTERS.—White granules which effervesce on the addition of water.

Dose, 60 to 180 gr.—4 to 12 grms.—for repeated administration; for a single administration **½ to 1 oz.—16 to 32 grms.**—in 3 to 6 fl. oz. of water.

3. Magnesii Carbonas Ponderosus.—Heavy Magnesium Carbonate. $(MgCO_3)_3,Mg(OH)_2,4H_2O$.

SOURCE.—Mix strong boiling aqueous solutions of magnesium sulphate and sodium carbonate. Evaporate.

CHARACTERS.—A white granular powder, feebly soluble in water; 3½ times as heavy as the light carbonate.

IMPURITIES.—Lime, sulphates.

Dose, 5 to 20 gr.—3 to 12 decigrms.—for repeated administration, **30 to 60 gr.—2 to 4 grms.**—for a single dose.

Preparations.

Liquor Magnesii Bicarbonatis. *Synonym.*—Fluid magnesia. Carbonic acid gas under a pressure of three atmospheres is passed into a mixture of freshly prepared magnesium carbonate and distilled water. It is kept securely corked. *Characters.*—A clear effervescing fluid. *Strength.*—10 gr. of the carbonate in 1 fl. oz. or 2 grms. in 100 millilitres.

This is Liquor Magnesii Carbonatis, B. P. 1898.

Dose, 1 to 2 fl. oz.—30 to 60 mils.

Heavy Magnesium Carbonate is contained in Trochiscus Bismuthi Compositus.

4. Magnesii Carbonas Levis. — Light Magnesium Carbonate. $(MgCO_3)_3,Mg(OH)_2,4H_2O$.

SOURCE.—Made like the heavy carbonate, except that the solutions are mixed cold and boiled after mixture.

CHARACTERS.—A very light white powder. Partly amorphous, with slender microscopic prisms intermixed. Very insoluble.

Dose, 5 to 20 gr.—3 to 12 decigrms.—for repeated

administration; **30 to 60 gr.—2 to 4 grms.**—for a single dose.

5. Magnesia Ponderosa.—Heavy Magnesia. MgO. *Synonyms.*—Heavy calcined magnesia, Heavy magnesium oxide.

Source.—Heat the heavy carbonate to expel the CO_2.

Characters.—A white powder, very insoluble in water, $3\frac{1}{2}$ times as heavy as the light.

Dose, 5 to 20 gr.—3 to 12 decigrms.—for repeated administration; **30 to 60 gr.—2 to 4 grms.**—for a single dose.

6. Magnesia Levis.—Light Magnesia. MgO. *Synonyms.*—Light calcined magnesia, Light magnesium oxide.

Source.—Heat the light carbonate to expel the CO_2.

Characters.—A light bulky white powder, feebly soluble.

Dose, 5 to 20 gr.—3 to 12 decigrms.—for repeated administration; **30 to 60 gr.—2 to 4 grms.**—for a single dose.

Pulvis Rhei Compositus contains heavy or light magnesia.

Action of Magnesium Salts.

External.—None.

Internal.—*Stomach and Intestines.*—Magnesia and the magnesium carbonate are antacid, acting in many ways like the potassium and sodium alkalies. The carbonic acid given off, if the carbonate has been given, is sedative to the stomach. They are both decomposed by the gastric juice, the chloride, lactate, and bicarbonate of magnesium being formed. These, or the sulphate if that has been taken, act in the intestine as typical saline purgatives. The sulphate is most powerful and is one of the best of saline purgatives, for the intestinal cells have very little selective action for either ion, therefore most of the drug remains in the intestine (*see* p. 97).

Blood and Urine.—Like other alkaline remedies, these magnesium salts increase the alkalinity of the blood, alkalize the urine, and are diuretic. But their action on the blood and urine is feebler than

that of salts of potassium and sodium, for they are with difficulty absorbed.

Nervous System.—Large doses given intravenously are powerful depressants to the whole nervous system, an action immediately abolished by calcium.

THERAPEUTICS OF MAGNESIUM SALTS.

Internal.—*Stomach.*—Magnesia and the carbonate may be used in the same cases as other alkalies. By alkalizing the gastric contents they hinder the absorption of alkaloids. They are therefore antidotes to these substances; the objection to them is their bulk. Magnesia is preferable, as the carbonate gives off carbonic acid gas. They must be freely given. The sulphate is an antidote to lead and barium salts, forming insoluble sulphates.

Intestines.—The magnesium salts are common purgatives. Magnesia, the carbonate, and fluid magnesia are excellent for children. The sulphate, one of our best saline purgatives, is very largely used, especially for constipation associated with hepatic disorder, gout, or excessive uric acid. Its use is then spread over some time, and it may conveniently be taken as one of the mineral waters which contain it and sodium sulphate (*see* p. 148). A concentrated solution, causing profuse secretion of intestinal fluid, is a useful purge for dropsy or ascites. Given every hour for a day it is an excellent drug for clearing out the bowels in bacillary dysentery.

Blood and Kidneys.—So little of these salts is absorbed, that they are rarely given for their alkaline effects on the blood and urine. For tetanus 1·5 to 2 c.c. (25 per cent. solution of magnesium sulphate) for each kilo of body weight has been injected subcutaneously every six hours, or 1 c.c. for each kilo intraspinally, but without advantage.

GROUP IV.

Plumbum, Argentum, Zincum, Cuprum, Bismuthum, Aluminium.

The pharmacopœial salts of these metals are **powerful astringents. Many** of them have some salts which are **emetics**, and others which, when applied locally, are **caustic.**

PLUMBUM.

Lead. Symbol, Pb. Atomic weight, 207·1. (Not official.)

1. Plumbi Oxidum.—Lead oxide. PbO. *Synonym.*—Litharge.

SOURCE.—Made by roasting lead in air.

CHARACTERS.—Pale brick-red heavy scales. Insoluble in water, soluble in nitric and acetic acids.

IMPURITIES.—Copper, iron, carbonates.

Preparation.

Emplastrum Plumbi. *Synonym.*—Diachylon. This is LEAD OLEATE, and is sometimes called lead soap. Lead oxide, 4, is boiled in water, 4, and olive oil, 8 (glyceryl oleate). $3PbO + 3H_2O + 2(C_3H_5,3C_{18}H_{33}O_2) = 3(Pb2C_{18}H_{33}O_2)$, lead oleate, $+ 2(C_3H_5,3OH)$, glycerin.

Emplastrum Plumbi is contained in Emplastra Hydrargyri, Resinæ, and Saponis.

2. Plumbi Acetas.—Lead Acetate. $Pb(C_2H_3O_2)_2,3H_2O$. *Synonym.*—Sugar of lead.

SOURCE.—Dissolve lead oxide or lead carbonate in acetic acid and water.

CHARACTERS.—White small monoclinic prisms, slightly efflorescent and of a sweet taste. *Solubility.*—10 in 25 of water.

INCOMPATIBLES.—Hard water, mineral acids and salts, alkalies, lime water, potassium iodide, vegetable astringents, preparations of opium, and albuminous liquids.

IMPURITY.—Lead carbonate.

Dose, 1 to 5 gr.—6 to 30 centigrms.

Preparations.

1. Pilula Plumbi cum Opio.—Lead acetate, 80; opium, 12; syrup of glucose, 8. *Strength.*—12 per cent. of opium.

Dose, 2 to 4 gr.—12 to 25 centigrms.

2. Suppositoria Plumbi Composita. — Lead acetate, 2·4; opium, 0·8; oil of theobroma, q.s. to make twelve suppositories. *Strength.*—Each contains 0·2 grm. (about 3 gr.) of lead acetate and 0·067 grm. (about 1 gr.) of opium.

Preparations made from the Acetate in which Lead exists as the **Subacetate,** $Pb_2O(C_2H_3O_2)_2$.

1. Liquor Plumbi Subacetatis Fortis.—Strong solution of lead subacetate. *Synonym.*—Goulard's extract. Lead acetate, 250; lead oxide, 175; water, 1000. A dense, clear, colourless liquid, sweet astringent taste, alkaline reaction. Sp. gr. 1·275. *Strength,* 24 per cent. of the subacetate.

2. Liquor Plumbi Subacetatis Dilutus. *Synonyms.*—Goulard water, Goulard's lotion. Liquor Plumbi Subacetatis Fortis, 12·5; water, 1000.

3. Glycerinum Plumbi Subacetatis—Strong solution of lead subacetate, 500; glycerin, 500; distilled water a sufficiency. Sp. Gr. 1·48.

4. Unguentum Plumbi Subacetatis.—Strong solution of lead subacetate, 12·5; wool fat, 25; hard paraffin, 12·5; soft paraffin, 50.

3. Plumbi Iodidum.—Lead Iodide. PbI_2.

SOURCE.—Mix solutions of lead nitrate or lead acetate and potassium iodide and dry the precipitate.

CHARACTERS.—Heavy bright yellow powder or crystalline scales almost insoluble in water.

Preparation.

1. Unguentum Plumbi Iodidi.—Lead iodide, 1; benzoated lard, 9. In India, benzoated suet may be used instead of benzoated lard.

ACTION.

External.—The action of lead salts on the unbroken skin, if they have any, is very slight; but when applied to the abraded skin, to sores and to ulcers, they coagulate the albumen of the discharge, thus forming a protective coat; they coagulate the albumen in the tissues themselves; and they directly,

not reflexly, contract the small vessels; for these three reasons they are powerfully astringent. They also soothe pain, and are therefore excellent local sedatives. It is obvious that substances so markedly astringent will be hæmostatics. Any salt may be irritant and caustic if enough is used and it is sufficiently concentrated.

Internal.—Lead salts act on mucous membranes precisely as on the broken skin, and are therefore powerfully astringent and hæmostatic to all parts of the alimentary canal, from the mouth downwards. In the stomach they are converted into a chloride. Lead excites tonic contractions of unstriped muscle, hence the colic and abortion caused by it. (For other actions *see* Toxicology.)

Therapeutics.

External.—Lead salts are applied as lotions or ointments in many conditions for which an astringent, sedative effect is desired, as in weeping eczema and many varieties of ulceration. The glycerin of the subacetate diluted fourfold with glycerin or milk is very useful for these conditions. The lotions may be injected in vulvitis, leucorrhœa, gleet, and otorrhœa, but should not be applied for ulceration of the cornea, lest the white precipitate formed should lead to permanent opacity. Their sedative effect is well seen in their use in pruritus, but of course the cause of the itching should if possible be removed. The Liquor Plumbi Subacetatis Fortis is rarely used, as it is strong enough to irritate; the dilute form is that usually employed when a lotion is desired. It is often applied to bruises when the skin is unbroken, but it is doubtful if it is absorbed. The ointment of the subacetate is an excellent remedy, and a lotion of lead and opium is a favourite preparation. It may be made by mixing 5 gr. (3 decigrms.) of dried extract of opium with 1 fl. oz. (30 mils) of Liquor Plumbi Subacetatis Dilutus and 1 fl. oz. (30 mils) of water.

Diachylon ointment consists of equal parts of lead plaster and soft paraffin melted together, and mixed with an equal quantity of zinc oleate ointment and mercuric oleate ointment it forms a transparent ointment excellent for many purposes.

Internal.—The chief uses of lead salts (the acetate is the only one given internally) are as astringents in severe diarrhœa, such as that of typhoid fever, and as hæmostatics, as in gastric ulcer, or in hæmorrhage from the intestine, especially if severe, as in typhoid fever or tuberculosis. For these purposes the Pilula Plumbi c̄ Opio is very valuable, and the suppositories may be employed for rectal hæmorrhage. Lead salts produce marked constipation. Other drugs are generally preferred, but the subacetate of lead may be used as a gargle, or painted on as the glycerinum when an astringent effect on the mouth or pharynx is desired.

Toxicology.

Acute Lead Poisoning.—As when applied externally, so when taken internally, the salts of lead, if concentrated, are powerful irritants. Cases of acute poisoning are rare. The acetate is most frequently taken. There is a burning, sweetish taste in the mouth, thirst, vomiting, abdominal colic, and usually constipation, but if the bowels are open the fæces are black; the skin is cold, and there is collapse. If the patient live long enough, cramps in the legs, giddiness, torpor, coma, and convulsions are present. *Post mortem.*—The stomach and intestines show signs of irritant poisoning.

Treatment.—Give emetics (*see* p. 145), or wash out the stomach. Give sodium or magnesium sulphate to form an insoluble sulphate, and to open the bowels. If collapse is present, stimulants and warmth should be used.

Chronic Lead Poisoning.—This is so common that it is fully described in text-books on medicine. Among those who work in lead, it usually occurs because the dust in the air they breathe contains minute particles of lead compounds; formerly it was thought that they generally were taken into the body with food because the workers did not wash their hands before meals. Those who work at white-lead factories are very liable to it. It has also occurred in many ways

from the impregnation of food and water with lead, especially from the storage of soft water in leaden cisterns and pipes.

Symptoms.—The earliest are constipation and intestinal colic. Lead is certainly absorbed, for it circulates in the blood and is excreted by the bowel and kidneys. It is supposed to be taken up as an albuminate. After absorption it diminishes the amount of hæmoglobin and the number of red blood-corpuscles, and produces a sallow anæmia; it checks the separation of urates from the blood and their excretion by the kidneys, hence gout is very common in those poisoned by lead. As it circulates in the gums, and the lead-impregnated plasma bathes their epithelium, through which some of the sulphur in the food and in the tartar of the teeth has diffused, a lead sulphide is precipitated in the gums, and forms the well-known very dark blue line at the base of the teeth. For the same reason a blue line may occasionally be seen round the anus, and, after death, deposits of pigment in the intestines. Circulating in the nervous system, lead very often produces chronic inflammation of the peripheral nerves, especially those supplying the extensors of the hand, and hence wrist-drop is a common symptom; but any muscles, and sometimes almost all the muscles of the body, may be paralysed from neuritis. It is noteworthy that the supinator longus usually escapes. The sensory fibres of the nerves are not often affected, hence pain and anæsthesia are rare; but pains, especially round the joints, may occur. In exceptional cases the anterior cornua of the spinal cord waste, and lead often affects the brain, causing saturnine lunacy, and also convulsions, known as saturnine epilepsy. Inflammation of the optic nerve, or optic neuritis, sometimes occurs, leading to blindness, which, however, may be present without any change in the nerve. The kidneys are often the seat of chronic inflammation; whether this is due to the passage of the lead through them, or to the gout caused by the lead, is an open question. The treatment consists chiefly in avoidance of the source of poisoning. Potassium iodide is often given, as it is supposed to increase the excretion of lead in the urine. This is probably incorrect. Very little lead passes out by the urine; most leaves the body by the fæces. It is said also to be excreted in the bile, sweat, and milk. For a clinical account of the symptoms and treatment a text-book of medicine must be consulted.

Pregnant women suffering from lead poisoning commonly abort and the drug has been frequently used as an abortifacient. Lead plaster or any combination of lead with higher fatty acids has by the Privy Council been deemed a Poison in Pt. I. of the Poisons Act 1908.

ARGENTUM.

Silver. Symbol, Ag. Atomic weight, 107·93. (Not official.)

1. Argenti Nitras.—Silver Nitrate. $AgNO_3$. *Synonym.*—Lunar caustic.

SOURCE.—Obtained by the interaction of silver and nitric acid.

CHARACTERS.—Colourless, tabular, right rhombic crystals. *Solubility.*—2 in 1 of water. Should be kept in the dark, as light blackens it.

INCOMPATIBLES.—Alkalies and their carbonates, chlorides, acids (except nitric and acetic), potassium iodide, solutions of arsenic, and astringent infusions.

IMPURITIES.—Other nitrates.

Dose, $\frac{1}{4}$ to $\frac{1}{2}$ **gr.—16 to 30 milligrms.**—in a pill with kaolin.

2. Argenti Nitras Induratus. *Synonym.*—Toughened caustic.

SOURCE.—Fuse together silver nitrate, 19 parts, and potassium nitrate, 1 part, and pour into proper moulds.

CHARACTERS.—White or greyish-white cylindrical rods or cones. Freely soluble in water.

3. Argenti Nitras Mitigatus. *Synonym.*—Mitigated caustic.

SOURCE.—It is a mixture made by fusing together one part of silver nitrate and two parts of potassium nitrate. The product is poured into moulds.

CHARACTERS.—White or greyish-white rods or cones. Freely soluble in water.

ACTION.

External.—The action of silver salts is very like that of lead salts, but they are more powerful. Therefore silver nitrate is much used as a caustic but it does not act deeply; it is consequently an admirable agent when we wish a limited caustic action on any particular part. Lotions of it may be used as astringents, but they are not so useful as lead lotions, for they are more irritating and cause pain. Silver salts, like lead salts, are hæmostatic, acting in precisely the same way. Weak solutions

of the nitrate stimulate to healthier action indolent ulcers and other inflamed surfaces.

Internal.—Silver salts, when locally applied to the mucous membrane of the mouth, act as on the abraded skin. In the stomach the nitrate is decomposed; we do not know what compound is formed, but it is said to have no astringent action. Silver is absorbed from the alimentary tract, for its long-continued use leads to a permanent dark bluish-slate colour first of the lips, inside of the cheeks, gums, nostrils, and eyelids, and later of the skin (argyria). This colour is due to the deposition of minute granules of metallic silver. Very little is known about its further action. In acute poisoning severe vomiting and nervous symptoms, as convulsions, are met with; the chronic form, seen more often when silver was frequently prescribed internally, is shown by paralysis like that due to lead, albuminuria, and the discoloration above mentioned. Some is passed in the fæces as the sulphide; some is deposited in the internal organs, especially the kidney.

Therapeutics.

External.—Nitrate of silver is much used because it is from its limited action one of the best caustics, and may be employed to destroy warts and exuberant granulations, or to apply to bites; but it must be remembered that it is of no use when an extensive or deep action is required. Because of its combination of an irritant stimulating effect with an astringent influence, lotions of it, of generally about 5 gr. to the fluid ounce of water, are of much benefit when applied as a paint to indolent ulcers, to bedsores, to the affected parts in chronic pharyngitis or laryngitis, or as an injection in gleet or inflammation of the os uteri. A urethral bougie should contain $\frac{1}{4}$ gr.

(16 milligrms.). Weaker solutions (2 gr., 12 centigrms., to 1 fl. oz., 30 mils) are employed for granular lids and various forms of ophthalmia. Solutions of the nitrate will sometimes relieve pruritus, and may be applied to the red skin of a threatening bedsore; very strong solutions have been recommended as a local application in erysipelas. Tinea tarsi is often treated by the application of solid silver nitrate, and ulcers of the mouth and other parts may be touched with it. It is an excellent hæmostatic for leech-bites. It is also applied to smallpox vesicles to prevent pitting, to boils, and to the uterus in chronic cervical catarrh. Protargol, a protein compound containing 8 per cent. of silver, easily soluble in water, is used as an injection for gonorrhœa. The usual strength is 1 per cent. Largin (Protalbin silver) is a similar compound. Collargol (Colloid silver) being opaque to X-rays has in 20 per cent. solution been injected into the ureter and renal pelvis for diagnostic purposes.

Internal.—Silver salts are not much used internally, and their continuous employment is objectionable on account of the argyria produced. They were formerly often given in nervous diseases, but there is no evidence that they did any good. Although it is said that the compound of silver formed in the stomach is non-astringent, nitrate of silver will certainly check severe diarrhœa, especially that of children. Sixty grains of nitrate of silver dissolved in three pints of tepid water, and injected high up the rectum, have been used with great benefit in dysentery.

ZINCUM.

Zinc. Symbol, Zn. Atomic weight, 65·37. (Not official.)

1. Zinci Chloridum.—Zinc Chloride. $ZnCl_2$.

SOURCE.—Zinc chloride is prepared by the interaction of hydrochloric acid and zinc.

CHARACTERS.—Colourless opaque rods or tablets, very deliquescent and caustic. *Solubility.*—Freely soluble in alcohol, ether, and water if a trace of acid is present.

IMPURITIES.—Iron, calcium, and sulphates.

Preparation.

Liquor Zinci Chloridi.—Granulated zinc, 40; hydrochloric acid, 110; water, 100.

ACTION OF ZINC CHLORIDE.

External.—It is very caustic, penetrating deeply, and limited in its effect to the seat of application. It is strongly antiseptic, and a solution of it of sp. gr. 2·0, known as Sir Wm. Burnett's fluid, is used as a domestic antiseptic.

Internal, *see* Toxicology.

THERAPEUTICS OF ZINC CHLORIDE.

External.—It is used as a powerful caustic, and is often made into sticks with plaster of Paris to destroy warts, nævi, condylomata, lupoid patches, &c. For the same purposes it may be made into a paste with equal parts of starch or flour. Either the liquor, or Burnett's fluid, may be employed to wash out bed-pans, closets, &c., but chloride of zinc is not so commonly used as other antiseptics. It is not given internally.

TOXICOLOGY.

Chloride of zinc is a corrosive irritant poison, causing a sensation of burning in the mouth and throat, abdominal pain, vomiting—the vomit containing blood, mucus, and shreds of mucous membrane—violent purging, and collapse. *Post mortem.*—The appearances are those produced by an acute irritant.

Treatment.—Wash out the stomach, or give emetics (*see* p. 145), and then demulcents (*see also* p. 145).

2. Zinci Sulphas.—Zinc Sulphate. $ZnSO_4,7H_2O$.

SOURCE.—Made by the interaction of zinc and sulphuric acid.

CHARACTERS.—Minute colourless prisms, very like sulphate of magnesium, but having a metallic taste. *Solubility.*—10 in 7 of water.

IMPURITIES.—Lead, iron, copper, arsenic.

INCOMPATIBLES.—Alkalies and their carbonates, lime water, lead acetate, silver nitrate, astringent vegetable infusions or decoctions, and milk.

Dose, 1 to 3 gr.—6 to 20 centigrms. (tonic); **10 to 30 gr.—6 to 20 decigrms.** (emetic).

Preparation.

Unguentum Zinci Oleatis.—Dissolve zinc sulphate, 30 grms., in distilled water, 60 millilitres; also dissolve 90 grms. of hard soap in shavings in 600 millilitres distilled water. Mix the two solutions. Collect the zinc oleate; dry it and add an equal weight of white soft paraffin.

3. Zinci Carbonas. — Zinc Carbonate, Zinc Hydroxycarbonate.

SOURCE.—Boil together solutions of zinc sulphate and sodium carbonate. Dry the precipitated zinc salt.

CHARACTERS.—A white tasteless powder, insoluble in water. Similar in constitution to magnesium carbonate.

IMPURITIES.—Sulphates, chlorides, copper.

Rarely used except to make the oxide and the acetate.

4. Zinci Oxidum.—Zinc Oxide. ZnO.

SOURCE.—Prepared from metallic zinc by combustion in air.

CHARACTERS.—A soft, nearly white, tasteless powder, insoluble in water.

IMPURITIES.—The carbonate and its impurities.

Dose, 3 to 10 gr.—2 to 6 decigrms.

Preparation.

Unguentum Zinci.—Zinc oxide, 15; benzoated lard, 85. In India benzoated suet should be used instead of benzoated lard.

5. Zinci Oleostearas.—Zinc Oleostearate.—Hard soap, 2; curd soap, 1; zinc sulphate, 1; water a sufficiency. Made by mixing a solution of the soaps with one of the sulphate of zinc.

CHARACTERS.—A white amorphous powder, insoluble in water and alcohol.

6. Zinci Acetas.—Zinc Acetate. $Zn(C_2H_3O_2)_2,2H_2O$.

Source.—Dissolve the zinc carbonate in acetic acid and water, and boil. Zinc acetate crystallizes out.

Characters.—Thin, translucent, colourless, crystalline plates, with a pearly lustre and a sharp taste. *Solubility.*—10 in 25 of water.

Impurities.—Those of the carbonate.

Incompatibles.—The same as of the sulphate.

Dose, 1 to 2 gr.—6 to 12 centigrms.

7. Zinci Valerianas, *see* Valerianæ Rhizoma.

Action of Zinc Sulphate, Carbonate, Oxide, Oleostearate, and Acetate.

External.—These salts, when applied to the broken skin or an ulcerated surface, are all astringents, acting by precipitating the albumen in the discharge and also that in the tissues. Thus they resemble lead and silver salts, but as a whole they are less powerfully astringent. The most active of them are the sulphate and acetate, whilst the carbonate and oxide are very weak. All these zinc salts are mild hæmostatics.

Internal.—*Alimentary canal.*—They all have an astringent effect on the gastric and intestinal mucous membranes. The sulphate, and to a less degree the carbonate, in doses of about 20 grains (12 decigrms.) are prompt emetics. They act directly on the stomach, and have the advantage of producing very little depression.

Remote effects.—Very little is known about the remote action of zinc salts, nor do we know how they act on the blood. It has been stated that they are depressant to the nervous system as a whole, and that they act as remote astringents, and will therefore arrest hæmorrhage from the uterus, kidneys, &c.; but this statement is probably incorrect. The prolonged administration of zinc salts causes symptoms

like those of lead poisoning. Probably the symptoms of which those who work with zinc sometimes complain are due to arsenic and other metals which contaminate compounds of zinc.

Therapeutics of Zinc Sulphate, Carbonate, Oxide, Oleostearate, and Acetate.

External.—A solution of the sulphate, generally about 2 gr. (12 centigrms.) to 1 fl. oz. (30 mils), usually coloured red with compound tincture of lavender, and then called Lotio Rubra, is very often applied for its astringent effect to all sorts of raw surfaces and ulcers, and as an injection in gonorrhœa, leucorrhœa, vulvitis, or otitis. Plain solutions of this strength may be applied to the eye for conjunctivitis. A urethral bougie should contain a grain; sometimes a grain of the alcoholic extract of belladonna is added. A 1 per cent. solution of zinc sulphate in normal saline forms a good spray for disinfecting the nasal cavities of carriers of the meningococcus. The oleostearate is an excellent application to sores and ulcers when a less astringent preparation is required; and the oxide and carbonate, either dusted on the parts or used as an ointment, are in constant use for cases in which only a mild astringent effect is desirable. An ointment, often known as Unguentum Metallorum, consists of equal parts of ointments of zinc oxide, lead acetate, and dilute mercuric nitrate. This is a very good application for many varieties of eczema, sores, and ulcers. Equal parts of zinc oleostearate, mercuric oleate, and diachylon ointment (p. 173) form an ointment which has the great advantage of being transparent, and therefore the progress of the disease can be observed without washing off the ointment. Calamine (impure zinc carbonate) is an excellent slight astringent for skin diseases. An ointment (1 to 5 of benzoated lard) and a lotion (prepared calamine,

15 gr. (1 grm.); zinc oxide, 15 gr. (1 grm.); lime water, 80 ♏ (5 mils); glycerin, 20 ♏ (12 decimils); water, 1 fl. oz. (30 mils)) are good preparations. The following sometimes succeeds in pruritus: Zinc oxide, 150 gr. (10 grms.); gelatin, 120 gr. (8 grms.); glycerin, 6 fl. dr. (24 mils); water to 6 fl. oz. (180 mils). The jelly to be melted when used, and applied with a brush, and then covered with cotton wool.

Internal.—*Alimentary canal.*—On account of their disagreeable taste, solutions of zinc salts are not used as astringents to the mouth. Applied by electrolysis zinc is useful for pyorrhœa. Small doses of the oxide or sulphate may be given as astringents in diarrhœa. The sulphate is a very good emetic for cases of poisoning, for it acts promptly without causing much nausea and hardly any depression. It is occasionally given as an emetic to children suffering from laryngitis or bronchitis.

Remote effects.—Because it was believed to be a depressant to the nervous system, zinc sulphate was formerly given in hysteria, epilepsy, whooping-cough, and chorea in doses of 1 to 3 grains (6 to 20 centigrms.) thrice a day. It is usually said to be a tonic, but there is no trustworthy evidence for this statement. The oxide given internally will occasionally check the night-sweats of phthisis.

CUPRUM.

Copper. Symbol, Cu. Atomic weight, 63·57. (Not official.)

Cupri Sulphas.—Copper Sulphate. $CuSO_4,5H_2O$. *Synonyms.*—Blue vitriol; Bluestone; Cupric sulphate.

Source.—Obtained by the interaction of water, cupric oxide or copper, and sulphuric acid.

Characters.—Deep blue crystals in triclinic prisms. Taste, styptic. *Solubility.*—1 in 3·5 of water. Solution strongly acid.

Impurity.—Iron.

INCOMPATIBLES.—Alkalies and their carbonates, lime water, mineral salts (except sulphates), iodides, and most vegetable astringents.

Dose, $\frac{1}{4}$ to 2 gr.—16 to 120 milligrms. (astringent); **5 to 10 gr.—3 to 6 decigrms.** (emetic).

ACTION.

External.—In the solid form copper sulphate is, when applied to raw surfaces, a powerful caustic. In dilute solutions it is **astringent**, acting like zinc sulphate, but more powerfully. Copper salts are strongly antiseptic.

Internal.—*Alimentary canal.*—Here also, if very concentrated or given in large doses, copper sulphate is an acute caustic irritant, but poisoning by it is very rare. In medicinal doses it is strongly astringent. Five to ten grains of the sulphate form a powerful emetic, acting directly on the stomach. As it is more irritating than zinc sulphate, it acts more readily, but it has the disadvantage that, if it fails to act, the stomach must be promptly emptied by some other means, for if not the copper sulphate will cause inflammation of it.

Remote effects.—Copper salts are slowly absorbed, and copper is chiefly re-excreted by the liver in the bile.

THERAPEUTICS.

External.—The sulphate is applied as a caustic to reduce exuberant granulations, and is used for tinea tarsi, being rubbed on the edges of the lids; as it is milder than nitrate of silver, it causes less pain. The "lapis divinus," which is often used for this last purpose, consists of copper sulphate 3 oz. (100 grms.), potassium nitrate 3 oz. (100 grms.), alum 3 oz. (100 grms.), camphor 60 gr. (4 grms.). The first three are fused together. The camphor is added, and the mass is cast into cylindrical moulds.

Lotions of copper sulphate, usually about 2 gr. (12 centigrms.) to 1 fl. oz. (30 mils), may be applied as astringents for just the same purposes as lotions of zinc sulphate; but it must be remembered that they are more powerful. This is the usual strength for solutions which are to be dropped into the eye. Rather stronger solutions are mild hæmostatics.

Copper oleate made, with lanolin, into an ointment of a strength of 10 to 20 per cent. is an excellent parasiticide for ringworm.

Internal.—In small doses copper sulphate is valuable for severe diarrhœa; usually it is given by the mouth in the form of a pill, but it may be given as a rectal injection. It is a rapid emetic, and may be employed in laryngitis and bronchitis in children, and in cases of narcotic poisoning, for which it is useful on account of its prompt action. It is particularly serviceable in phosphorus poisoning, for if it is used copper is deposited on the phosphorus, rendering it inert. It is usual to give three or four grains of the sulphate in water every few minutes till vomiting takes place. After emetic doses of copper sulphate there is generally only one act of vomiting, but by that the stomach is completely emptied. Very little is known about the remote action of salts of copper, but it was formerly stated that the sulphate would cure chlorosis.

Toxicology.

In sufficient doses salts of copper are violent gastro-intestinal irritants, but acute poisoning is very rare.

Copper may be taken in very small quantities for a long time without producing any ill-effects, for many persons habitually consume, without harm, preserved vegetables, the green colour of which is due to preparation with copper.

It has been thought that coppersmiths are particularly liable to phthisis, but they are not more prone to it than the followers of other dusty trades. Workers in brass may suffer from anæmia, a green line on and at the bases of the teeth, wasting, weakness, dyspepsia, tremors, headache, vague pains,

pharyngeal and laryngeal catarrh with occasional hæmoptysis and aphonia, and profuse secretion of sweat which may be green. These symptoms are thought to be due to the copper contained in brass. Sometimes colic is due to the contamination of copper and brass by lead.

BISMUTHUM.

Bismuth. Symbol, Bi. Atomic weight, 208·0. (Not official.)

1. Bismuthi Carbonas.—Bismuth Oxycarbonate. $2(Bi_2O_2CO_3),H_2O$. *Synonym.*—Bismuth subcarbonate.

Source.—It may be prepared by the interaction of bismuth nitrate and ammonium carbonate.

Characters.—A heavy white powder, insoluble in water.

Impurities.—As of the subnitrate.

Dose, 5 to 20 gr.—3 to 12 decigrms.

Preparation.

Trochiscus Bismuthi Compositus.—Bismuth oxycarbonate, 0·15 grm.; heavy magnesium carbonate, 0·15 grm.; precipitated calcium carbonate. 0·3 grm.; and a rose basis.

2. Bismuthi Subnitras.—Bismuth Oxynitrate $BiONO_3,H_2O$.

Source.—Prepared by the interaction of bismuth nitrate and water.

Characters.—A heavy white powder in minute crystalline scales. Insoluble in water, but soluble in dilute nitric acid.

Incompatibles.—With water it always yields a little free acid, and hence leads to the liberation of carbonic acid gas from bicarbonate of sodium, or if prescribed with potassium iodide leads to the liberation of iodine. Bismuth salts form tannate of bismuth when prescribed with substances containing tannin.

Impurities.—Lead, arsenic, tellurium, chlorides, nitrates.

Dose, 5 to 20 gr.—3 to 12 decigrms.

Preparation.

Liquor Bismuthi et Ammonii Citratis. *Synonym.*—Liquor Bismuthi.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

3. Bismuthi Salicylas.—Bismuth Salicylate or Bismuth Oxysalicylate. $BiOC_7H_5O_3$.

Source.—May be prepared by the interaction of bismuth nitrate and sodium salicylate.

CHARACTERS AND TESTS.—A white or nearly white heavy amorphous powder insoluble in water, alcohol, and glycerin. It gives the reactions for bismuth and a violet colour with ferric chloride.

Dose, 5 to 20 gr.—3 to 12 decigrms.

ACTION.

External.—Salts of bismuth have no action on the unbroken skin. Dusted on a raw surface they form a protecting coat, are feebly germicidal, and are very mildly astringent.

Internal.—If large doses of salts of bismuth are injected under the skin of animals, or if large doses of soluble salts are given to them by the mouth, they produce effects as severe as those due to antimony. The chief are gastro-intestinal irritation and fatty degeneration, and it is stated that some very susceptible persons may be poisoned by large doses by the mouth of insoluble salts; but, as a rule, any symptoms of gastro-intestinal irritation caused by the insoluble salts of bismuth are due to the arsenic with which bismuth salts, especially the subnitrate, may be contaminated. When pure, it is probable that these salts, like any bland heavy powder, act chiefly as protectives to the gastro-intestinal mucous membrane. They have an astringent action, diminishing secretion, and are gastro-intestinal antiseptics. The subnitrate is believed to be the most powerful in the last direction because in contact with water it tends to split up into bismuth oxide and nitric acid, and in the intestine bismuth sulphide is formed, and nitrous vapours, which are antiseptic, are liberated, but it may be that it acts as an oxygen carrier like arsenic, for the oxide certainly appears to act in this way. Bismuth is very slowly absorbed and excreted chiefly in the urine, and it may be found in the liver, kidneys, spleen, and nervous system. Nothing certain is known of any remote effects. Bismuth leaves

the rectum as the sulphide, and colours the fæces black. It may cause a purplish line on the gums. The breath of persons taking salts of bismuth occasionally has an odour like onions, due to contamination of the bismuth with traces of tellurium.

THERAPEUTICS.

External.—Salts of bismuth may be dusted on sores as protectives and mild astringents; for this purpose the oxychloride, much used as a cosmetic (blanc de perle), is the best. The following is a good bismuth ointment:—Bismuth oxide 1 part, and oleic acid 8 parts, stirred in with 3 parts of white wax liquefied by heat, with 9 parts of soft paraffin. The subnitrate is sometimes snuffed up the nose during a cold, and suspended in mucilage it may be used as an injection for gonorrhœa or leucorrhœa. Dermatol, which is bismuth subgallate, has been employed as an ointment and dusting powder. Wounds have been dressed with bismuth preparations, occasionally poisoning symptoms, just described as following subcutaneous injection, have ensued.

Internal.—The subnitrate and the carbonate are chiefly employed, and they seem to be more efficient than the soluble preparations. They must be suspended, preferably by means of compound tragacanth powder (not acacia, for with this a compact mass is formed at the bottom of the bottle); given thus they are more efficacious than as a lozenge. It is not known how the effect is produced, but either of these salts is remarkably efficient in removing gastric pain, whether due to ulcer or to gastritis, or even when no cause can be detected. The usual dose is 10 or 20 gr. (6 to 12 decigrms.). Both these drugs will often stop vomiting due to gastritis, gastric ulcer, chloroform, pregnancy, or indeed any other cause. For their astringent action

they are given in diarrhœa, doses of 60 gr. (4 grms.) being administered without any ill effect, and some believe that part of the benefit is due to the antiseptic action of bismuth salts. They appear sometimes to check the severe diarrhœa of tuberculous ulceration of the bowel. Their efficacy as gastric anodynes and as gastric astringents is much increased by combination with a little morphine, and if given as gastric sedatives the addition of sodium bicarbonate as well as the morphine is an advantage. In such a prescription the bismuth carbonate is preferable to the subnitrate, for the latter may act on the sodium carbonate and lead to the production of sufficient carbonic acid to drive the cork out of the bottle. Many think the insoluble oxychloride (dose, 5 to 20 gr., 3 to 12 decigrms.) a more useful preparation than the subnitrate or the carbonate.

The salicylate has been largely used in various gastric affections. It is supposed to combine the virtues of bismuth salts with the antiseptic actions of salicylic acid. It easily splits up, and is therefore best given in cachets, but the following is a useful prescription for summer diarrhœa and cholera :—Salicylate of bismuth, 5 gr. (3 decigrms.); compound powder of cinnamon, $7\frac{1}{2}$ gr. (5 decigrms.); compound tincture of chloroform (B. P. 1885), 20 ♏ (12 decimils); aromatic spirit of ammonia, 20 ♏ (12 decimils); essence of peppermint, 10 ♏ (6 decimils); chalk mixture to 1 fl. oz. (30 mils). To be taken every three or four hours.

ALUMINIUM.

Symbol, Al. Atomic weight, 27·1. (Not official.)

1. Alumen Purificatum.—Purified alum. A sulphate of aluminium and potassium (potassium alum), $Al_2(SO_4)_3,K_2SO_4,24H_2O$, or a sulphate of aluminium and ammonium (ammonium alum), $Al_2(SO_4)_3,(NH_4)_2SO_4,24H_2O$.

SOURCE.—Made by the combination of aluminium sulphate with potassium sulphate or with ammonium sulphate.

CHARACTERS.—Acid, transparent, colourless crystalline masses, with a sweetish astringent taste. *Solubility.*—1 in 10 of cold water; 1 in 4 of glycerin.

INCOMPATIBLES.—Alkalies, lime, salts of lead, mercury, and iron, tartrates, and tannic acid.

IMPURITIES.—Iron sulphate and silicates.

Dose, 5 to 10 gr.—3 to 6 decigrms.

Preparation.

Glycerinum Aluminis.—Purified alum, 20; distilled water, 7·5; glycerin to produce 120·0.

2. Alumen Exsiccatum.—Exsiccated alum.

SOURCE.—Heat potassium alum till no more aqueous vapour is given off. It contains 45 per cent. less water than alum.

CHARACTERS.—A white powder or spongy masses. *Solubility.*—Slowly but completely soluble in water.

3. Kaolinum.—Kaolin.

A native aluminium silicate powdered and freed from gritty particles.

CHARACTER.—A soft white powder. *Solubility.*—Neither in water nor dilute acids.

It is contained in Pilula Phosphori.

ACTION OF ALUM.

External.—It has no action on the unbroken skin, but coagulates the albumen of the discharges from ulcers, sores, &c., and thus forms a protecting covering to the parts, and acts as an efficient astringent. The albumen in the tissues themselves is coagulated also. This coagulated albumen will compress and occlude the vessels, and thus alum is hæmostatic. Dried alum absorbs water, and therefore its solid form is mildly caustic.

Internal.—*Alimentary tract.*—Alum is an excellent astringent for the mouth, stomach, and intestines, and will cause constipation. In large doses it

is emetic, acting directly on the stomach, and in larger still, irritant and purgative. Most, if not all, is passed by the fæces; probably, in medicinal doses, it has no remote effects on the tissues.

Nervous system.—Given to animals in large dose it produces paresis, loss of sensation, forced movements, drowsiness, and death from respiratory paralysis.

Therapeutics of Alum and Kaolin.

External.—Alum is occasionally used as a caustic to destroy weak exuberant granulations. Kaolin is a good dusting powder. Fuller's earth, also a native aluminium silicate, is used as a dusting powder. Because of its astringency alum has many uses; it may, for example, be applied to weeping eczematous surfaces, and as an injection or soaked on lint for vulvitis of children. Solutions of it have been used for leucorrhœa and gleet. Ten grains to the fluid ounce of water is a common strength for most purposes. Five grains to the fluid ounce make a good eye wash or a gargle. Strong solutions or powdered alum applied locally stop bleeding, if it is not severe, such as occurs from piles, leech-bites, slight cuts, the gums, and the nose. Alumnasol, or alumnol, an aluminium salt of naphthol-sulphonic acid, is very soluble. It forms an excellent lotion or ointment for raw surfaces.

Kaolin resists most chemical reagents, and therefore it is used as a basis for making pills of such bodies as phosphorus, silver nitrate, or potassium permanganate, for with them chemical reaction would occur if an ordinary basis were used.

Internal. — *Alimentary canal.* — As a mouth wash or gargle (5–10 gr. to 1 fl. oz., 3–6 decigrms. to 30 mils) alum is very valuable in ulcerative stomatitis, in aphthous conditions of the mouth, and in slight pharyngitis or tonsillitis, or

Glycerinum Aluminis may be painted on with a camel's-hair brush. If the nose be irrigated with a solution of alum it may remedy a chronic ozæna. Other astringents are preferable for bleeding from the stomach and for diarrhœa, but a teaspoonful of alum dissolved in simple syrup and given every quarter of an hour till vomiting is produced is an excellent emetic for children, and may be used to produce vomiting in laryngitis and bronchitis, as it is non-depressant. Milk curdled by alum, may be given in the diarrhœa of typhoid fever. In lead colic alum may open the bowels, probably because, being a sulphate, it precipitates any lead salts as insoluble sulphates. A suspension of equal parts of koalin and water is given in half-pint doses half hourly for twelve hours for cholera with success. It acts by absorption of toxins.

GROUP V.

Iron and Manganese.

Some authorities consider that the action of these drugs is somewhat similar.

IRON.

Ferrum. Symbol, Fe. Atomic weight, 55·84. (Official.)

1. Ferrum.—Annealed iron wire, diameter 0·1 millimetre (No. 35 wire gauge), or wrought-iron nails, free from oxide.

Metallic iron is pharmacopœial in two forms, viz. this and reduced iron.

Preparation.

Vinum Ferri. *Synonym.*—Steel wine. Iron wire, 1; sherry, 20.

Dose, 1 to 4 fl. dr.—4 to 16 mils.

2. Ferrum Redactum.—Reduced Iron. A fine powder containing not less than 80 per cent. of metallic iron with a variable amount of iron oxide.

SOURCE.—Ferric hydroxide is heated in a gun-barrel, and reduced by having hydrogen passed over it.

CHARACTERS.—A greyish-black powder, strongly attracted by the magnet.

IMPURITY.—Sulphur.

Dose, 1 to 5 gr.—6 to 30 centigrms.

Preparation.

> **Trochiscus Ferri Redacti.** *Strength.*—0·06 grm. or 1 gr. of reduced iron in each with a simple basis.

The following (viz. the sulphate, the saccharated carbonate, the saccharated phosphate, and the iodide) *are ferrous salts*: that is to say, salts of the lower oxide of iron, FeO. The iodide is not itself official, but a preparation containing it is.

3. Ferri Sulphas.—Ferrous Sulphate. $FeSO_4,7H_2O$.

SOURCE.—Iron wire is dissolved by boiling in sulphuric acid and water. The sulphate is crystallized out.

CHARACTERS.—Pale green, oblique rhombic prisms, with a styptic taste. *Solubility.*—1 in $1\frac{1}{3}$ of water.

IMPURITIES.—Per-salts of iron, copper.

Dose, 1 to 5 gr.—6 to 30 centigrms.

Preparation.

> **Mistura Ferri Composita.** *Synonym.* — "Griffith's mixture." Ferrous sulphate, 6; potassium carbonate, 8; myrrh, 15; glucose, 15; gum acacia, 15; spirit of nutmeg, 10; rose water, to 1000. It is a dark green mixture containing the iron carbonate, for the iron sulphate and the potassium carbonate act on each other.
>
> **Dose, $\frac{1}{2}$ to 1 fl. oz.—15 to 30 mils.**

4. Ferri Sulphas Exsiccatus. — Exsiccated Ferrous Sulphate. Contains not less than 77 per cent. of pure anhydrous ferrous sulphate $FeSO_4$.

SOURCE.—Ferrous sulphate is deprived of part of its water of crystallization.

CHARACTERS.—A dirty white powder which easily absorbs water, and therefore pills made of it may spoil. $2\frac{1}{2}$ gr. = 4 gr. of the sulphate.

Dose, $\frac{1}{2}$ to 3 gr.—3 to 20 centigrms.

Preparations.

1. Pilula Ferri. *Synonym.*— Blaud's pill. Exsiccated ferrous sulphate, 33; exsiccated sodium carbonate, 21; gum acacia, 8; tragacanth, 2; glucose, 31; water, a sufficiency. This pill contains 22·5 per cent. of ferrous carbonate, the same change taking place as in Mistura Ferri Composita.

Dose, 5 to 15 gr.—3 to 10 decigrms.

2. Pilula Aloes et Ferri, *see* Aloes.

5. Ferri Carbonas Saccharatus.—Ferrous carbonate, more or less oxidized and mixed with glucose. Contains not less than 50 per cent. of ferrous salts calculated as ferrous carbonate, $FeCO_3$.

Characters.—Greenish-brown powder of a sweetish taste. It is a very unstable compound, being easily oxidized. The sugar in both this preparation and in Blaud's pill forms a coating, and prevents further oxidization. The saccharated carbonate of iron should not be given in a mixture, for the sugar is dissolved out, and then the compound can decompose.

Impurities.—Ammonium sulphate, excess of iron oxide.

Dose, 10 to 30 gr.—6 to 20 decigrms.—in a cachet or as a lozenge.

6. Ferri Phosphas Saccharatus.—Saccharated Iron Phosphate. It contains not less than 60 per cent. of ferrous salts, mixed with glucose and calculated as ferrous phosphate, $Fe_3(PO_4)_2,8H_2O$.

Characters.—A slate-blue amorphous powder, partly soluble in water. Taste sweetish.

Impurity.—Arsenic.

Dose, 5 to 10 gr.—3 to 6 decigrms.

Preparation.

1. Syrupus Ferri Phosphatis.—Dissolve iron wire, 8·6; in concentrated phosphoric acid, 62·5; syrup, 700; distilled water to 1000. *Strength.*—10 millilitres contain 0·18 grm. of anhydrous ferrous phosphate, 1 gr. in each fluid drachm.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

2. Syrupus Ferri Phosphatis cum Quinina et Strychnina. *Synonyms.*—Easton's Syrup, Syrupus

Trium Phosphatum. Iron wire, 8·6; concentrated phosphoric acid, 62·5; powdered strychnine, 0·57; quinine sulphate, 14·8; syrup, 700; water to make 1000. *Strength.*—10 millilitres contain 0·18 grm. anhydrous ferrous phosphate, 0·148 grm. of quinine sulphate, and 0·0057 grm. of strychnine; 1 fl. dr. contains 1 gr. anhydrous ferrous phosphate, $\frac{4}{5}$ gr. quinine sulphate, and $\frac{1}{32}$ gr. strychnine.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

7. Syrupus Ferri Iodidi.—Make a hot solution of iron wire and iodine in water and add to it glucose and syrup. It is colourless. *Strength.*—10 millilitres contain 0·7 grm. of ferrous iodide; 1 fl. dr. contains 3·75 grs. This preparation is approximately two-thirds the strength of that of B.P. 1898.

It is very liable to change, forming the oxyiodide of iron and free iodine, which makes it yellow. This alteration cannot be prevented, but it may be retarded by adding some more glucose. Because the Syrupus Ferri Iodidi is so liable to change, a patient should not buy more than 3 or 4 fl. oz. at a time. The iodide may be given as a pill in the same way as recommended for Hydrargyri Iodidum Viride (*see* p. 213). When the syrup has turned yellow, it may be made colourless by exposing it to direct sunlight, for then the iodine becomes hydriodic acid.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

The two following (viz. the perchloride and the persulphate) *are ferric salts*; they are compounds of the higher oxide of iron, Fe_2O_3.

8. Liquor Ferri Perchloridi Fortis.—Strong solution of Ferric Chloride.

Source.—Boil iron in hydrochloric acid and water. Nitric acid is then added, and thus the ferrous is converted into ferric chloride. *Strength.*—20 per cent. of iron.

Characters.—An orange-brown liquid, usually containing some free hydrochloric acid.

Impurities.—Ferrous salts.

Preparations.

1. Liquor Ferri Perchloridi.—The strong solution, 25; water, to 100.

Dose, 5 to 15 m.—3 to 10 decimils.

2. Tinctura Ferri Perchloridi.—The strong solution, 25; alcohol (90 per cent.), 25; water, to produce 100. It will be noticed that the Liquor and the Tincture are the same strength. When exposed to light they become paler, because some of the iron is reduced to the ferrous state. Glycerin, which is frequently prescribed with perchloride of iron to cover the rough taste, slowly does the same, but this change does not appear to influence the therapeutic efficacy of perchloride of iron.

Dose, 5 to 15 m.—3 to 10 decimils.

9. Liquor Ferri Persulphatis.—Solution of Ferric Sulphate. $Fe_2,3SO_4$.

SOURCE.—A hot solution of ferrous sulphate in sulphuric acid and water is boiled with nitric acid and water.

CHARACTERS.—A dark red very astringent solution, miscible with water.

The following are scale preparations of iron, so called because they are dried to form scales. They are not well-defined chemical compounds. The base of all is ferric hydrate. There are three—the tartarated iron, the ammonio-citrate, and the citrate of iron and quinine.

10. Ferri et Potassii Tartras.—Tartarated Iron. (Ferrum Tartaratum B.P. 1898.)

CHARACTERS.—Garnet-coloured scales, slightly sweetish and astringent. *Solubility.*—1 in 4 of water; feebly in spirit.

IMPURITIES.—Ammonia and ferrous salts.

Dose, 5 to 10 gr.—3 to 6 decigrms.

11. Ferri et Ammonii Citras.—Iron and Ammonium Citrate.

CHARACTERS.—Red scales like the tartarated iron, but not so deep in colour. *Solubility.*—10 in 5 of water; almost insoluble in spirit.

IMPURITIES.—Tartrates and alkaline salts.

Dose, 5 to 10 gr.—3 to 6 decigrms.

Preparation.

Vinum Ferri Citratis.—Iron and ammonium citrate, 18 gr.; orange wine, 1000.

Dose, 1 to 4 fl. dr.—4 to 16 mils.

12. Ferri et Quininæ Citras.—Iron and Quinine Citrate.

CHARACTERS.—Greenish-yellow scales of a bitter taste. *Solubility.*—2 in 1 of water.

IMPURITIES.—Alkaline salts and other alkaloids instead of quinine.

Dose, 5 to 10 gr.—3 to 6 decigrms.

INCOMPATIBLES OF IRON SALTS IN GENERAL.—All substances containing tannic or gallic acid form an intense black with per-salts of iron. Preparations of iron are therefore incompatible with all vegetable astringent solutions, and the only infusions with which they can be prescribed are infusion of quassia and infusion of calumba. It is a common mistake to forget that because of its tannin, the tincture as well as the infusion of digitalis makes an inky mixture with iron preparations. Such a mixture may be clarified with a little dilute phosphoric acid, but after a few days a slight precipitate of phosphate of iron falls. Per-salts of iron render mucilage of acacia gelatinous.

Alkalies and their carbonates, lime water, carbonate of calcium, magnesia and its carbonate give green precipitates with ferrous, and brown with ferric salts. The scale preparations of iron, however, are not precipitated by alkaline solutions.

ACTION OF IRON AND ITS SALTS.

External.—Solutions of iron salts are antiseptic. They have no action on the unbroken skin, but when applied locally to the abraded skin, sores, ulcers, and mucous membranes, either in solution or when dissolved by the secretions, the ferric salts are powerful astringents, because they coagulate albuminous fluids, both those discharged from the surface and also those in the tissue itself. There is no direct effect on the walls of the vessels, but the contraction of the coagulated albumen compresses them and diminishes their calibre. Partly for this reason, but still more because these salts of iron quickly cause the coagulation of blood, and the clot thus formed plugs the bleeding vessels, they are among the best local hæmostatics we possess, and will often

arrest very severe hæmorrhage. The perchloride and the sulphate are very strongly astringent; but the scale preparations, steel wine, reduced iron, the carbonate and the phosphate of iron are so very feebly astringent that they are never used as local applications; in fact, to most persons they are non-astringent. Oxides of iron have the property of converting oxygen into ozone, and are therefore disinfectant.

Internal.—*Mouth.*—Preparations of iron have a styptic taste, the teeth and tongue may be blackened when they are taken, owing to the formation of the sulphide of iron, the sulphur being derived from the food and the tartar on the teeth; hence it is advisable to take iron preparations through a glass tube or a quill. The astringent preparations have, when locally applied, the same action on the mucous membrane of the mouth as on the raw skin.

Stomach.—Whatever form of iron is given by the mouth, it is converted in the stomach into ferric chloride, with probably a little ferrous chloride. Long experience has shown that ferric chloride is to the physician a most valuable preparation of iron; probably this is because it will not abstract hydrochloric acid from the gastric juice as is the case with all other preparations of iron. It is often stated that an albuminate of iron is formed in the stomach; this is incorrect unless more iron is given than can unite with the hydrochloric acid, and when albuminate of iron is given by the mouth it will be converted into a chloride in the stomach. Although whatever form of iron is administered ferric chloride is formed in the stomach, the choice of the preparation is a matter of great importance; for if strongly acid salts are given, the acid set free after the formation of the chloride will act as an irritant, and damage the mucous membrane; even the preparations of the perchloride may do this, for they often contain a considerable

amount of free acid. These facts explain why iron preparations, especially the acid ones, so often cause headache, nausea, loss of appetite, and other symptoms of severe indigestion. We also learn why experience has taught that the sulphate, which is so often used, should be given in the form of a pill, for this, especially if coated, is not dissolved till the intestine is reached, and the acid is harmless in the alkaline solutions of that part of the alimentary canal. Further, we see why the preparations which are either not acid at all or only very slightly acid, such as the reduced iron, dialysed iron (B. P. 1885), the carbonate, and the scale preparations, do not as a rule cause indigestion. The perchloride of iron is very astringent, hence the astringent effect on the stomach of iron salts. The non-astringent preparations can only be astringent in proportion to the amount of ferric chloride formed from them by the gastric juice; but if large quantities of astringent preparations are given, the excess which is not decomposed by the gastric juice will add its astringency to that of the perchloride formed in the stomach.

Intestines.—On passing into the intestine, the contents of which are alkaline from carbonate of sodium, the ferric chloride becomes an oxide of iron, which remains in solution owing to the presence of organic substances; the subchloride is converted into ferrous carbonate, which is also soluble. Lower down in the intestine, by the action of the sulphur compounds, the nascent hydrogen, and other readily oxidized products of decomposition there present, these compounds of iron are converted into the ferrous sulphide and tannate (the tannic acid being derived from the vegetables in the food), and as such are eliminated with the fæces, which are turned black. Large amounts of the astringent preparations have a constipating effect; this is owing to there being an excess of them, so that they are not acted upon

in the stomach or intestines, for the oxides and carbonates are non-astringent preparations.

Absorption.—Iron is certainly taken up from the alimentary canal, for the growing child gets from its food all the iron necessary for its increase in weight, but as the total amount of iron in the adult body is only about 38 grains ($2\frac{1}{2}$ grms.), it is probably absorbed very slowly in very minute amounts, and as iron in food exists as organic compounds, there is no doubt about the absorption of organic iron. Whether, however, inorganic iron salts can be absorbed has been much discussed.

The prevailing opinion, founded chiefly on histological evidence, now is that they can be taken up by the intestinal epithelium and passed into the leucocytes of the blood in minute particles. This iron is first deposited in the spleen, but later on is conveyed to the liver, where it is built up into complex bodies—one of which is called ferratin—which are the precursors of hæmoglobin; where in the body this is finally made is not known, but the red marrow utilizes it to make red blood-corpuscles. Any excess of iron in the liver, after resting there some time, is taken away by the blood and excreted into the intestine.

The opinion formerly held was that inorganic iron salts are not absorbed. The chief reason for this view was that the giving of such salts by the mouth does not lead to more iron in the urine; but we now know that this is because in such a case the excess of iron taken up is excreted into the intestine as an organic compound, and as it has been shown that under all circumstances the bile contains the merest traces of iron this excretion must take place by the intestinal mucous membrane. Indeed, the excretion of iron has been shown to take place in the large intestine only, whilst its absorption takes place in the upper part of the small intestine.

Blood.—It is often stated that giving iron causes, in healthy subjects, an increased number of red blood-corpuscles, but this is very doubtful. Probably in health it has little or no effect on the blood.

Iron salts injected into animals subcutaneously or directly into the veins cause gastro-intestinal irritation and paralysis from depression of the central nervous system. Part of the iron is stored up, but much is excreted by the gastro-intestinal mucous membrane. The amount in the urine is hardly increased. Iron given during hæmorrhage maintains the hæmoglobin at the same point as before the hæmorrhage.

In certain forms of anæmia (a condition in which either the amount of hæmoglobin and the number of corpuscles are diminished, or they appear to be owing to an excess of the plasma), especially chlorosis, the administration of iron rapidly improves the blood in all respects. It is therefore said to be hæmatinic; and as an improvement in the quality of the blood leads to an improvement in the functions of all the organs of the body, iron is also called a tonic. Tonics are drugs which indirectly improve the action of the several organs of the body; usually they act by improving the quality of the blood or by aiding digestion, and thus rendering the digestion and absorption of food more easy (*see* p. 122). If, as already stated, inorganic iron is directly taken up by the intestinal epithelium and passed to the leucocytes, the benefit in anæmia is easy to understand. But we have seen that formerly it was believed that inorganic iron is not absorbed, and if this be so, it is at first sight difficult to understand how it can benefit anæmia. As the organic iron in food must be absorbed we must conclude that it is in some way or other protected from decomposition in the alimentary canal, if we believe that the inorganic compounds which would

result if it was decomposed are incapable of absorption. Bunge's hypothesis was that in some forms of anæmia, especially chlorosis, organic salts of iron taken in the food are in some way split up in the intestine so as to be incapable of absorption. In those anæmic conditions which can be benefited by iron the administration of the inorganic salts prevents the decomposition of the organic salts in the food by fixing the excessive amount of decomposing agents, which according to Bunge are chiefly alkaline sulphides, and forming sulphide of iron. This, he says, is supported by the fact that to cure chlorosis rapidly enormous doses of iron are often found necessary; for example, a patient will take 5 grains (·33 grm.) of reduced iron three times a day, or 15 grains (1 grm.) a day. Now, the whole amount of iron in the blood of an ordinary healthy woman is about 38 grains (2·5 grms.), for there is only one atom of iron in a molecule of hæmoglobin, which contains considerably over 2000 atoms. Supposing she had lost half her hæmoglobin, if the iron given were simply absorbed, one day's treatment might almost restore her to health, but it is well known that weeks are often required. But if this view were correct we should expect that bismuth, manganese, or arsenic, by fixing the decomposing agents, would cure chlorosis as efficiently as iron. It has been stated that they will, but Stockman has published results which point in a contrary direction, and he has shown that sulphide of iron will cure chlorosis although on Bunge's hypothesis it should not, for it will not fix the decomposing agents if they are alkaline sulphides; also there is in chlorosis no excess of these sulphides in the intestine. Further, many think that it is not necessary to give large doses of iron to cure chlorosis. Iron injected subcutaneously cures chlorosis, but this does not tell in one direction more than another, for it may be excreted into the intestine and there fix

the alkaline sulphides. Thus the evidence is strongly opposed to Bunge's view.

Remote effects.—As iron in anæmic subjects increases the amount of hæmoglobin, more oxygen is carried to the tissues, and thus the whole body shares in the benefit of a course of iron, which has also been thought to have a direct effect on the kidneys as a mild diuretic, and a direct effect in promoting the menstrual flow. These actions are, however, slight, and may be due to the general improvement in health. Iron salts have been given to produce abortion, but without any result. Remote astringent effects have been attributed to them, but there is no satisfactory proof that they have any; and indeed, when we remember that very little if any iron is absorbed in an astringent form, and it cannot exist in the blood in such a form, we should hardly expect that salts of iron could be remotely hæmostatic or astringent. Iron is chiefly stored in the spleen, lymphatic glands, liver, and marrow; possibly it is by stimulating the activity of this that iron cures chlorosis.

Excretion.—One milligramme of iron is eliminated daily in the urine, and this remains constant under all circumstances. Any excess of elimination following subcutaneous injection, or excessive absorption from the intestine, takes place through the intestinal mucous membrane.

Therapeutics of Iron and its Salts.

External.—Solutions of the sulphate, the perchloride, and the Liquor Ferri Subsulphatis, $Fe_4O(SO_4)_5$, strength 43 p.c., official in the United States (Monsel's solution), are very valuable local astringents. It matters very little which of these is used. In England one of the solutions of the perchloride is perhaps oftenest employed. Either is of service in many cases—for

example, to stop hæmorrhage from leech-bites, from the nose, from piles, or from the uterus, as in the hæmorrhage of malignant disease. A convenient way to apply them is on lint or cotton wool soaked in the solution, and a cavity such as the nose or uterus may be plugged with the lint. The aqueous solution of the perchloride has been used as a spray for hæmoptysis, but as it may excite coughing it is not to be recommended. It is very useful as an astringent for painting on the fauces, pharynx, or tonsils in inflammation of these parts. It may for this purpose be diluted with an equal quantity of water, or a solution of 1 part of perchloride of iron in 4 of glycerin may be used. It has been advised to paint erysipelatous skin with the tincture of perchloride of iron. A solution of the sulphate (1 gr. to 1 fl. oz., 6 centigrms to 30 mils) has been used in gleet.

Internal.—*Gastro-intestinal tract.*—The astringent preparations may be swallowed in cases of severe bleeding from the stomach, such as that of malignant disease, ulcer, or cirrhosis. If the bleeding is profuse, a drachm of the Liquor Ferri Perchloridi with a drachm of glycerin to facilitate swallowing may be given every hour or oftener, and this will sometimes apparently save a patient's life. For less serious hæmorrhage smaller quantities will suffice. Intestinal hæmorrhage may also be treated in the same way.

The tendency of the per-salts of iron to constipate is usually overcome by the addition of some purgative; thus magnesium sulphate is commonly given with the perchloride, and aloes is often prescribed with iron sulphate in a pill. The per-salts have been given for diarrhœa, but there are many drugs more suitable for this symptom. Chronic constipation is often very effectually treated by a pill of iron sulphate and extract of nux vomica,

but probably the efficient purgative in it is the nux vomica, although some claim that large doses of iron sulphate will overcome chronic constipation. Anyhow, the constipating effect of the ferric salts is often much exaggerated.

A rectal injection of a fluid drachm of the tincture of the perchloride of iron to half a pint of water kills threadworms.

Arsenical poisoning is best treated by the humid peroxide of iron, which should be freshly prepared by mixing together 3 fl. oz. (90 mils) of Liquor Ferri Perchloridi with 1 oz. (32 grms.) of sodium carbonate diluted with water. Half an ounce should be given every five or ten minutes. An insoluble arsenite is formed, and may be got rid of by a thoroughly purgative dose of magnesium sulphate or some other simple purge. A dose of common salt or sodium bicarbonate, followed by 1 fl. oz. (30 mils) of the Liquor Ferri Dialysatus of the B.P. 1885 diluted with water, is also efficient in poisoning by arsenic.

Blood.—The great use of iron salts is to restore the blood to its normal condition in anæmia, especially chlorosis. They are useless in pernicious anæmia and generally of little value, if any, in the anæmia of leucocythæmia, exophthalmic goitre, or Hodgkin's disease. All other common forms of anæmia are secondary to some definite cause, such as hæmorrhage, lead poisoning, scurvy, &c., and are treated by the removal, if possible, of the cause of the anæmia, but recovery may be aided by the administration of iron. The perchloride and the sulphate of iron are two of the most efficacious preparations, and pills containing a grain of the dried sulphate, with aloes or nux vomica if constipation is present, or the Pilula Ferri, are very valuable. It is usual to begin with one pill containing one grain of the dried sulphate of iron thrice a day, but gradually the number of pills may be increased till three or

four are taken at a dose. This method of large doses of the sulphate often appears to cure more rapidly than smaller doses. If these astringent preparations cause indigestion, any of the milder preparations may be substituted. The carbonate may be given in pills in rapidly increasing doses, or the dose of reduced iron, conveniently given on bread and butter, may be pushed. Mistura Ferri Composita is a disagreeable preparation to take and to look at. The styptic taste of some of the preparations, especially the astringent ones, may be concealed by giving them with a drachm of glycerin, which acts by its viscosity and by reducing some of the ferric to a ferrous salt. It is often added to the tincture of the perchloride. The scale preparations hardly ever disagree, they are therefore used for patients with a delicate digestion, and for such it is much better to make no attempt to rapidly increase the dose, but to depend on small doses spread over a long period. Liquor Ferri Albuminatis (dose, 1 to 4 fl. dr., 4 to 6 mils), Liquor Ferri Peptonatis (dose, 1 to 4 fl. dr., 4 to 6 mils), and dialysed iron (dose, 10 to 30 ♏, 6 to 18 decimils), all in the B. P. C., are very useful non-official preparations for anæmic persons whose digestion is weak. The last should be given as drops or with glycerin. Mineral waters containing iron (such as those of La Bourboule and Levico) may be given in such cases (*see* p. 231). Flitwick water contains a good deal. Often iron and quinine citrate is prescribed as a pill; powdered tragacanth and syrup form the best excipient. Treatment of anæmia by iron leads, of course, to the improvement of the numerous symptoms, such as amenorrhœa, constipation, dyspepsia, &c., which are dependent upon the anæmia. That form of neuralgia which is associated with anæmia usually yields to iron.

Syrupus Ferri Phosphatis cum Quinina et Strychnina (*see* p. 193), or Easton's syrup, is a very

popular preparation; it is used for anæmia, and to promote the health and appetite during convalescence after long illnesses. A pill very similar to the syrup, and containing iron phosphate, 1 gr. (6 centigrms.); quinine, 1 gr. (6 centigrms.); strychnine, $\frac{1}{32}$ gr. (2 milligrms.); concentrated phosphoric acid, $1\frac{1}{2}$ ♏ (9 centimils); liquorice powder to 5 gr. (3 decigrms.), is prepared. It is called Easton's pill, or Pilula Trium Phosphatum. A similar tablet is in the market.

The iodide of iron has been given, sometimes apparently with success, in cases of rheumatoid arthritis, but it must be continued thrice daily for many months. A pill is often preferable to the syrup, as that so readily changes. Two grains may be made into a pill in the same way as that advised for the green iodide of mercury (*see* p. 213), and one or two such pills may be given thrice a day.

Large doses of iron (10 or even 20 minims of the tincture of the perchloride every hour or two) have been given in diphtheria and other forms of bad sore-throat, such as hospital sore-throat, apparently with considerable benefit. Erysipelas has been treated in the same way. Fever due to other causes is said to contra-indicate the use of iron.

Kidneys.—Iron salts are reported to have a feeble diuretic action, but this is doubtful. The perchloride is often given empirically for all forms of Bright's disease. Whether it does good unless anæmia is present is undecided.

As iron is liable to cause indigestion, it should not be given near a meal. Occasionally a patient is found who cannot take iron in any form, because of the headache and indigestion caused by it. If it is desired to give it subcutaneously 1 to 2 gr. of the soluble iron pyrophosphate dissolved in 10 ♏ of water may be administered daily. Cacodylate of

iron ($\frac{3}{4}$ to $1\frac{1}{2}$ gr. dissolved in 15 ♏ of water) may be injected daily into the gluteal muscles.

The different preparations of iron.—These have already been classified into astringent and non-astringent. There are some, viz. the iodide, the phosphate, and the citrate of iron and quinine, the value of which depends in part at least upon their other ingredient. The arsenate (not official) must be given in such small doses to avoid arsenical poisoning that it is probable the iron in it has no effect. Hence arsenious acid may just as well be given, and this is commonly done. The iron phosphate, which always contains some free phosphoric acid, is an excellent hæmatinic. It is used largely for children, because the syrup of it is very pleasant in taste, and also because it was formerly believed that the phosphoric acid would aid the growth of bones, especially in cases of rickets. The iron iodide has been introduced for cases in which we wish to gain the benefit of both elements, but the proportion of iron to iodine is small (1 to $4\frac{1}{2}$). It is especially liable to damage the teeth. The citrate of iron and quinine combines the virtues of both iron and quinine. It is a favourite mild preparation for slight cases of anæmia, but must not be prescribed with alkalies, as they precipitate the quinine.

Parrish's Food.—(Not official.)

A complicated preparation, known also as Squire's Chemical Food. The Syrupus Ferri Phosphatis Compositus of the B.P.C. corresponds to it. The ingredients of this are iron wire, concentrated phosphoric acid, precipitated calcium carbonate, potassium bicarbonate, sodium phosphate, cochineal, sugar, orange flower, and distilled water.

Dose, $\frac{1}{2}$ to 2 fl. dr.—2 to 8 mils.

This is a pleasant preparation, given for the sake of the phosphates and iron in it. Children take it easily.

MANGANESIUM.

Manganese. Symbol, Mn. Atomic weight, 54·93. (Not official.)

Potassii Permanganas.—Potassium Permanganate. $KMnO_4$.

SOURCE.—It may be obtained by the interaction of potassium chlorate, potassium hydroxide, and manganese dioxide.

CHARACTERS.—Dark purple, delicate, slender prisms. *Solubility.*—1 in 20 of water; a grain gives a fine purple colour to a gallon of water.

INCOMPATIBLES.—It is very readily deoxidized in the presence of organic matter. It is usually given as a pill or a tabella, and should be made up with kaolin or paraffin, or an explosion will very likely take place.

IMPURITIES.—Potassium carbonate, black manganese oxide.

Dose, 1 to 3 gr.—6 to 20 centigrms., as a pill.

Preparation.

Liquor Potassii Permanganatis. *Strength.*—1 per cent. solution in distilled water. It has a very nasty taste, and is easily deoxidized in the presence of organic matters to a brown colour.

Dose, 2 to 4 fl. dr.—8 to 16 mils.

ACTION.

External.—In the solid form Potassium Permanganate is a mild caustic and is, when kept dry, a permanent salt. Its most important action is that when moist it readily gives up its oxygen to oxidize proteins, and hence combining with the proteins of micro-organisms kills them, and its solutions therefore quickly turn dark brown, manganese dioxide being formed. It is consequently a disinfectant, deodorant, and antiseptic. The nasal insufflation of 1 in 5000 solution in normal saline is useful in carriers of the meningococcus. But its action as a germicide is very limited, for it so readily gives up its oxygen to the organic substances in which the micro-organisms flourish that it very soon becomes inert.

Internal.—Potassium permanganate when taken internally must be quickly decomposed. Manganese salts are only absorbed from the intestine in extremely minute quantities. When they are

injected into the blood they are excreted in the urine and into the intestine. Probably they have no important action after absorption. Formerly it was thought that they could replace iron in the body, but this is not so. The red corpuscles do not take up manganese.

THERAPEUTICS.

External.—Although potassium permanganate is not of much practical use as a germicide, it is commonly employed as a deodorant for drains, bed-pans, to wash utensils, and to wash the hands; for the last purpose it is suitable as being non-irritant. It has one advantage: namely, that it is easy by its change in colour to see when it has lost its efficacy. 1 in 150 is a serviceable strength. Condy's red fluid consists of 8 grains (5 *decigrms.*) of sodium permanganate to the fluid ounce (30 mils) of distilled water. It is expensive for purposes requiring a large quantity. It stains fabrics. The stain may be got out by applying sulphurous acid, but the fabric must be immediately rinsed in water, for sulphuric acid is formed.

Internal.—The official liquor of potassium permanganate diluted to 1 in 50 can be used as a mouth wash or gargle in foul conditions of the mouth, or as an injection in cases of foul discharges, such as may occur with gonorrhœa, vaginitis, uterine disease, or ozæna. Some have considered that potassium permanganate is beneficial for the same cases of anæmia as iron, but probably it has no effect. Others praise its power in amenorrhœa. It is given for cholera. This drug should always be prescribed as a pill or tabella, for the taste of solutions of it is very nasty. It oxidizes morphine and is therefore an antidote to opium poisoning.

GROUP VI.

Containing **Mercury** only.

1. HYDRARGYRUM.

Mercury. Quicksilver. Symbol, Hg. Atomic weight, 200·6

SOURCE.—A liquid metal which may be obtained from native mercuric sulphide.

CHARACTERS.—A brilliantly lustrous fluid metal, easily divisible into small globules.

IMPURITIES.—Lead, tin, and other metals.

Preparations containing free mercury.

1. Hydrargyrum cum Cretâ. *Synonym.*—Grey powder. *Strength.*—1 of mercury with 2 of prepared chalk. By keeping, the mercury is liable to become mercuric oxide, which makes the powder more active.

Dose, 1 to 5 gr.—6 to 30 centigrms.

2. Emplastrum Hydrargyri.—Mercury, 328; olive oil, 18; sublimed sulphur, 2; lead plaster, 652. The sulphur provides the globules of mercury with a fine coat of sulphide of mercury, and this prevents their running together. *Strength.*—1 in 3 of mercury (approximately).

3. Linimentum Hydrargyri.—Mercurial ointment, 5; strong solution of ammonia, 4; camphor liniment, 8. *Strength.*—1 in 10 of mercury, nearly.

Contains $\frac{3}{5}$ of the amount of mercury B. P. 1898.

4. Pilula Hydrargyri. *Synonym.*—Blue pill. Mercury, 4; confection of roses, 6; liquorice, 2. *Strength.*—1 in 3 of mercury.

Dose, 4 to 8 gr.—25 to 50 centigrms.

5. Unguentum Hydrargyri. *Synonym.*—Blue ointment. Mercury, 30; benzoated lard, 65; prepared suet, 5. *Strength.*—1 in 3 of mercury. Approximately $\frac{3}{5}$ the strength of the corresponding preparation, B. P. 1898. After this ointment has been kept some time it contains metallic mercury, mercuric oleate, and mercurous and mercuric oxides.

In India benzoated suet should be used instead of benzoated lard.

6. Unguentum Hydrargyri Compositum. *Synonym.*—Scott's ointment. Mercurial ointment, 10; yellow wax, 6; olive oil, 6; camphor, in flowers, 3. *Strength.*—1 in 5 of mercury. Approximately ? the strength of the corresponding preparation, B. P. 1898.

2. Hydrargyri Oxidum Rubrum.—Red Mercuric Oxide. HgO. *Synonym.*—Red precipitate.

SOURCE.—Obtained by heating mercuric nitrate until acid vapours cease to be evolved.

CHARACTERS.—An orange-red powder or crystalline scales, almost insoluble in water.

IMPURITIES.—Red lead, brickdust, nitrate of mercury.

Preparation.

Unguentum Hydrargyri Oxidi Rubri. *Synonym.*—Red precipitate ointment. Red mercuric oxide, 1; yellow paraffin ointment, 9.

3. Hydrargyri Oxidum Flavum.—Yellow Mercuric Oxide. HgO.

SOURCE.—Obtained by the interaction of aqueous solutions of mercuric chloride and caustic soda.

CHARACTERS.—A yellow powder, insoluble in water. Not given internally. It is contained in Lotio Hydrargyri Flava. It has the same composition as the red oxide, but is amorphous.

Preparation.

Unguentum Hydrargyri Oxidi Flavi.—Yellow mercuric oxide, 1; yellow soft paraffin, 49.

4. Hydrargyri Perchloridum.—Perchloride of Mercury, Mercuric Chloride. *Synonym.*—Corrosive sublimate. $HgCl_2$.

SOURCE.—Heat a mixture of mercuric sulphate, sodium chloride, and manganese dioxide. The perchloride sublimes and is condensed.

CHARACTERS.—Heavy, colourless masses of prismatic crystals. *Solubility.*—1 in 18 of water; 1 in 3 of alcohol (90 per cent.). It must be dissolved in distilled water, for ordinary water decomposes it.

INCOMPATIBLES.—Alkalies and their carbonates, potassium iodide, lime water, tartar emetic, silver nitrate, lead acetate, albumen, soaps, vegetable preparations containing tannic acid, and in fact most substances.

Dose, $\frac{1}{32}$ to $\frac{1}{16}$ gr.—2 to 4 milligrms.

Preparations.

1. Liquor Hydrargyri Perchloridi.—Mercuric chloride, 1; distilled water, 1000. *Strength.*—0·1 per cent.; $\frac{1}{10}$ gr. in 110 m; 0·1 grm. in 100 millilitres.

Dose, 30 to 60 m.—2 to 4 mils.

2. Lotio Hydrargyri Flava. *Synonym.*—Yellow wash. Mercuric chloride, 4·6; lime water, 1000. *Strength.*—2 gr. in 1 fl. oz. nearly.

5. Hydrargyri Subchloridum.—Subchloride of Mercury, Mercurous Chloride. *Synonym.*—Calomel. HgCl.

SOURCE.—Obtained as a sublimate by heating a mixture of mercurous sulphate and sodium chloride.

CHARACTERS.—A dull white, heavy, insoluble, nearly tasteless powder.

IMPURITY.—Mercuric chloride.

Dose, $\frac{1}{2}$ to 5 gr.—3 to 30 centigrms.

Preparations.

1. Lotio Hydrargyri Nigra. *Synonym.*—Black wash. Calomel, 6·85; glycerin, 50; lime water, to make 1000. *Strength.*—3 gr. to 1 fl. oz. nearly.

2. Pilula Hydrargyri Subchloridi Composita. *Synonym.*—Plummer's pill. Calomel, 20; sulphuretted antimony, 20; guaiacum resin, 40; gum acacia, 1; tragacanth, 1; syrup of glucose, 10. *Strength.*—Calomel, 1 in $4\frac{1}{2}$ nearly.

Dose, 4 to 8 gr.—25 to 50 centigrms.

3. Unguentum Hydrargyri Subchloridi.—Calomel, 1; benzoated lard, 4.

This ointment is twice the strength of the corresponding preparation, B. P. 1898.

In India benzoated suet should be used instead of benzoated lard.

6. Hydrargyrum Oleatum.—Mercuric Oleate. Hydrargyri Oleas, B.P. 1898.)

Source.—Triturate mercuric oxide, 20; with liquid paraffin, 5; add oleic acid, 75; stir and heat.

Characters.—A light greyish yellow, oleaginous, semi-solid substance.

Preparation.

Unguentum Hydrargyri Oleati.—Mercuric oleate, 1; benzoated lard, 3.

In India benzoated suet should be used instead of benzoated lard.

7. Hydrargyri Iodidum Rubrum.—Red Iodide of Mercury, Mercuric Iodide, Biniodide of Mercury. HgI_2.

Source. — Obtained by the interaction of mercuric chloride and potassium iodide.

Characters.—A vermilion crystalline powder, feebly soluble in water, but easily in a solution of potassium iodide.

Impurities.—The same as of the perchloride.

Dose, $\frac{1}{32}$ to $\frac{1}{16}$ gr.—2 to 4 milligrms.

Preparations.

1. Liquor Arsenii et Hydrargyri Iodidi. *Synonym.*—Donovan's solution. Dissolve equal parts of arsenious iodide and mercuric iodide in water. A clear pale yellow liquid. *Strength.*—1 per cent. of each iodide.

Dose, 5 to 20 m.—3 to 12 decimils.

2. Unguentum Hydrargyri Iodidi Rubri.—Mercuric iodide, 1; benzoated lard, 24.

In India benzoated suet should be used instead of benzoated lard.

8. Hydrargyri Iodidum Viride.—HgI. (Not official.) Green Iodide of Mercury. *Synonym.*—Subiodide of mercury.

Source.—Rub together mercury and iodine with a few drops of spirit.

Characters.—A dull green powder insoluble in water. Must be kept in the dark, for it very soon becomes the red iodide. Keeps better if a slight excess of mercury is present.

Dose, $\frac{1}{6}$ to 2 gr.—10 to 120 milligrms.—in a pill. It is best prescribed thus: Hydrargyri Iodidum Viride, the required dose; milk sugar, $\frac{1}{2}$ gr.; excipient, q.s. The excipient has the following composition: Tragacanth powder (not Co.), 240 gr.; water, 240 m; syrup of glucose, ℥ij.

9. Liquor Hydrargyri Nitratis Acidus.—Mercuric Nitrate, or Pernitrate of Mercury. $Hg(NO_3)_2$ in solution in nitric acid.

SOURCE.—Dissolve 120 of mercury in 150 of nitric acid with 45 of water, and heat.

CHARACTERS.—A colourless, strongly acid liquid containing much free nitric acid. Sp. gr. 2·0.

IMPURITY.—Mercurous nitrate.

10. Unguentum Hydrargyri Nitratis. *Synonym.*—Citrine ointment.

SOURCE.—Mix a solution of 1 of mercury in 3 of nitric acid, with 4 of prepared lard and 7 of olive oil. In India benzoated suet should be used instead of benzoated lard.

CHARACTERS.—A lemon-yellow ointment.

Preparation.

Unguentum Hydrargyri Nitratis Dilutum. Mercuric nitrate ointment, 1; soft yellow paraffin, 4.

11. Hydrargyrum Ammoniatum.—Ammoniated Mercury. NH_2HgCl. *Synonyms.*—White precipitate, ammonio-chloride of mercury.

SOURCE.—Mix solutions of ammonia and perchloride of mercury. Filter and wash the precipitated ammoniated mercury.

CHARACTERS.—An opaque white powder, very insoluble.

IMPURITIES.—The same as of the perchloride.

Preparation.

Unguentum Hydrargyri Ammoniati. *Synonym.*—White precipitate ointment. Ammoniated mercury, 5; benzoated lard, 95.

This is approximately one-half the strength of the corresponding preparation, B. P. 1898.

In India benzoated suet should be used instead of benzoated lard.

ACTION OF MERCURY AND ITS SALTS.

External.—The perchloride of mercury is one of the most powerful and important antiseptics with

which we are acquainted. In 1870 it was discovered that 1 part in 6000 would kill infusoria and spermatozoa. Now it is known to be a universal germicide, entering the micro-organism and acting as a direct poison. The published results of experiments with it vary very much, because the duration of the action, the solvent, and the micro-organism experimented upon are not always the same. But speaking generally mercurials even in very dilute solution kill micro-organisms although they take rather long to act, but not so long as to interfere with their practical efficacy. A solution of 1 in 1000 is very commonly employed for many disinfecting purposes. If organic matter is present in the fluid to be disinfected, the mercury combines with the protein of this and the antiseptic value of the mercury is destroyed. This and the expense of mercurials prevents their use for disinfection of fæces, drains and suchlike purposes. The biniodide, dissolved in potassium iodide solution, is a powerful antiseptic. Metallic instruments cannot be disinfected with the perchloride, for mercury is deposited on them.

Most mercurials, especially the oleate, oxide ammoniate, nitrate, and perchloride, will destroy the animal and vegetable parasites that infest the skin; they are therefore **antiparasitic.** Also most of them will occasionally relieve itching, even when no cause is to be found.

The soluble salts are powerful irritants, for the albuminate of mercury formed is dissolved in the fluids of the tissues, and the acid of the mercurial salt exerts its irritant action; the acid solution of the nitrate is strongly caustic. Insoluble salts are slightly irritant and stimulating; calomel is sometimes applied to sores for this property.

Metallic mercury and its salts are **absorbed by the skin,** especially when rubbed in either as an oleate or an ointment. These preparations are also

taken up, although to a less degree, if simply applied to the skin, for minute particles of mercury or its salts pass into the hair follicles and sebaceous follicles, from which they are absorbed as an oxide or a chloride. All the symptoms of mercurial poisoning can be produced if the drug is absorbed through the skin. The vapour can be absorbed through the mucous membrane of the lungs, and mercury compounds are so volatile that when they are applied to the skin some usually enters the blood by the lungs.

Internal.—Although the different salts of mercury have different external actions, after absorption their actions are, in most respects, similar. The long-continued use of excessive doses of mercurials produces well-marked and important symptoms (*see* Toxicology). The actions for which mercurials are used in medicine are the following.

Stomach and Intestines.—The metal mercury itself and mercurous compounds, being mildly irritant in their action, are often used as purgatives; but the mercuric compounds given in the same doses produce severe gastro-intestinal irritation. The action is chiefly on the duodenum and upper part of the jejunum; the precise mode of irritation is unknown, but it is certain that, in consequence of the administration of the mercurial, the contents of the duodenum are hurried along before there is time for the bile to be reabsorbed or altered, and hence the motions are very dark-coloured. There is probably some, but not an excessive increased secretion from the intestinal walls, for the motions, although large and loose, are not watery. As the action of the mercurial is chiefly on the upper part of the intestine, it is greatly assisted by giving a saline purge a few hours after it, for this will act more on the lower part of the bowel. The contents are passed along so quickly, that it is doubtful whether there is time for much mercury to be absorbed if a purgative dose of

it has been given. Calomel and the metallic preparations are the two forms most used as purgatives. The former is the more powerful.

Whatever compound of mercury is taken by the mouth, it, in the stomach, becomes a complex albuminate containing mercury, sodium, chlorine, and albumen. This compound, in the presence of the sodium chloride in the stomach, can exist in solution there. This same compound is formed when perchloride of mercury is injected subcutaneously, and therefore the solution for injection should contain a little sodium chloride. Precisely what happens to it in the duodenum is doubtful, but it is quite certain that if the dose is insufficient to cause purgation some mercury is absorbed, the rest passing out of the bowel as a sulphide.

Liver.—It was formerly taught that calomel increased the amount of bile formed by the liver. This is now known to be an error, but perchloride of mercury may possibly slightly increase the quantity, and perhaps, occasionally when calomel is administered, some of it is converted into the perchloride. Calomel and, to a less extent, preparations of metallic mercury are, however, called **indirect cholagogues**, because they, in the manner already explained, aid the excretion of bile, and being powerful antiseptics increase its purgative action by preventing its decomposition, hence the stools are dark green; they contain calomel, mercuric sulphide, and unaltered bile.

Blood.—After absorption the mercurial compound formed in the stomach and intestines probably becomes oxidized, and circulates as an oxyalbuminate. Minute long-continued doses of mercury slightly increase the richness of the blood in red corpuscles, and may add a little to the weight of the body. **Large doses produce anæmia.** Mercury checks the emigration of white corpuscles, and this perhaps explains its antiphlogistic action.

Remote effects.—Mercury is chiefly excreted by the kidney and the bowel; in large doses it irritates the salivary glands and is a powerful sialogogue. Minute amounts are excreted by the sweat, milk, and bile. By itself it is in health a feeble diuretic, but it sometimes powerfully aids other diuretics when dropsy is present. It is eliminated very slowly, and hence accumulates in the body, especially in the liver, kidneys, and spleen.

Therapeutics of Mercury and its Salts.

External.—*Antiseptic action.*—Solutions of the perchloride are very largely employed. A strength of 1 in 1000 is used for washing the hands, for washing the parts to be operated upon, for soaking towels, lint, sponges, &c., used in operations, for washing infected articles, infected rooms, furniture, linen, &c. For wounds and cavities (as the uterus), the strength for a single washing should not exceed 1 in 2000, for continual irrigation 1 in 10,000. Corrosive sublimate discs, tinted blue, made so that one dissolved in a pint of water makes a solution of 1 in 500, are a convenient form in which to carry the antiseptic. Corrosive sublimate solutions should always be tinted blue to render them easy to recognize.

Antiparasitic action.—White precipitate ointment, dilute nitrate of mercury ointment, and a wash of the perchloride are very useful for destroying lice on the head; and these three, especially the last, are excellent for destroying the fungus in ringworm and favus. The mercuric oleate is useful for destroying that in pityriasis versicolor; if the skin is easily irritated the ointment of it should be used. Mercurials should not be applied over so large an area that there is a risk of poisoning from absorption.

Irritant action.—The acid solution of the nitrate

is used to destroy warts, condylomata, &c.; no doubt much of its caustic action is due to the free nitric acid it contains. Milder preparations, such as the dilute ointment of the nitrate, or the red oxide ointment if diluted, may be used for tinea tarsi; and the same ointments are very beneficial to any ulcer or sore that requires a stimulant, whether or not it be syphilitic. When a milder preparation is required calomel is often dusted on the part; and black wash is very commonly used, especially for syphilitic sores and condylomata.

Itching.—Black wash, yellow wash, or Unguentum Hydrargyri may be employed to relieve the itching of skin diseases, such as prurigo senilis and urticaria, if they are not too extensive. A very favourite ointment for many skin diseases is composed of equal parts of the dilute mercuric nitrate, zinc oxide, and lead acetate ointments (*see* p. 181).

Absorbent action.—All mercurial ointments and the oleate, when applied to or gently rubbed into any part which is chronically inflamed, often aid the absorption of the products of inflammation, if they are not too deep-seated. For this purpose blue ointment and Scott's ointment, or the oleate ointment, are very commonly used for chronic inflammation of joints, chronically enlarged glands, and chronic peritonitis, which certainly sometimes appears to be cured by the application of a binder spread with one of these preparations or the Linimentum Hydrargyri. even when the disease is tuberculous. Sixty grains (4 grms.) of blue ointment rubbed into the skin daily, using a different situation each day in the week, is a usual and very efficacious manner of treating syphilis. The ointment of the red iodide is in India applied to the thyroid gland in goitre.

Internal.—*Alimentary canal.*—Very dilute solutions of the perchloride (4 gr., 25 centigrms., to 10 fl. oz., 300 mils water with 1 fl. dr. 4 mils.

of dilute hydrochloric acid and a little glycerin) may be used as a mouth wash for syphilitic ulceration. Ringer advises grey powder in minute doses for the sudden vomiting immediately after food sometimes met with in children. By far the most important intestinal action of mercury is its purgative effect. Calomel and blue pill are pre-eminently the purgatives to employ when there is, from the headache, constipation, furred tongue, feeling of weight over the liver, and general lassitude, reason to suspect that the dyspepsia is hepatic. Either of these drugs at night, followed by a watery purge, as Mistura Sennæ Composita, in the morning, will often completely relieve the symptoms. The blue pill at night and black draught (Mistura Sennæ Composita) in the morning have long been a favourite combination. Mercury or calomel is also one of the best purgatives for cases of cirrhosis, and for cardiac cases in which there is considerable hepatic congestion. Grey powder mixed with a little sugar is an excellent purgative for children, or even for adults, when a very mild purge is required—as, for example, after severe enteritis or peritonitis, or if it is desirable to open the bowels during typhoid fever. Children take mercury very well. Infants can easily bear grain doses of the grey powder. As diarrhœa, especially in children, is so often due to the presence of some irritant, a simple purgative, as grey powder, will, by removing it, often cure the diarrhœa. This preparation hardly ever causes griping, but calomel is liable to do so. Mercury compounds, on account of their intestinal antiseptic action, have been given in Germany for typhoid fever (*see* pp. 86 and 100).

Remote uses.—In cases of heart disease mercury is often combined with digitalis and squill as a diuretic (as in the well-known Guy's diuretic pill: blue pill 12 gr., 8 decigrms., powdered squill root

12 gr., 8 decigrms., powdered digitalis leaves 12 gr., 8 decigrms., extract of hyoscyamus 20 gr., 12 decigrms.; make 12 pills), and in some cases this combination does great good.

Syphilis.—Mercury in any form is powerfully antisyphilitic. The perchloride is often used for adults, and grey powder for children. This action is so important that it makes mercury one of the most valuable drugs we have. It has been mentioned that it may be applied locally to syphilitic ulcerations, but to be of use it is essential that it should also be administered so as to reach the blood. It is probably efficacious by enabling the patient to form bodies poisonous to the spirochæta pallida, the cause of syphilis; it can completely cure the patient; its use must be long continued, but should never be pushed to salivation. Treatment should be begun as early as possible. It is especially valuable in the primary and secondary stages; also it is of great value in tertiary syphilis. It is as efficacious for the congenital as for the acquired disease. It is also administered for non-syphilitic varieties of chronic inflammation, but not so often as formerly. Patients with disease of the kidneys do not bear it well.

The [illegible] iodide was commonly prescribed for syphilis, a[illegible] succeeds when other preparations have failed. Its great disadvantage is its instability. Mercurous tannate (dose, 1 to 2 gr., 6 to 12 centigrms., in a pill) is strongly recommended.

Sal Alembroth.—(Not official.)

Ammonio-mercuric Chloride, a double chloride of mercury and ammonium.

Source.—Mix 271 parts of corrosive sublimate with 107 of ammonium chloride, both in solution, and evaporate.

Characters.—Flattened rhombic prisms, freely soluble in water or glycerin. It contains one molecule of corrosive sublimate combined with two of ammonium chloride. Three

grains of sal alembroth contain two grains of corrosive sublimate. It is a very powerful antiseptic, but does not combine with albumen so readily as perchloride of mercury, and it is therefore less irritating.

Action and Therapeutics.

Sal alembroth gauze (containing 1 per cent.) and sal alembroth wool (2 per cent.), both tinted with aniline blue, which is bleached by the discharge, so that it is easy to see if it has soaked through, are used to dress wounds antiseptically.

Sal alembroth injections ($\frac{1}{3}$ gr., 23 milligrms., in 10 ♏, 6 decimils, of water) are a convenient non-irritating form in which to inject mercury intramuscularly in syphilis.

Mercuro-zinc Cyanide.—(Not official.)

Consists of one molecule of mercuric cyanide combined with four molecules of zinc cyanide.

Characters.—A white powder.

Action and Therapeutics.

Mercuro-zinc cyanide gauze and wool, each containing 3 per cent. of the salt, and tinted mauve pink with rosolane, are used in antiseptic surgery as the salt is unirritating. It is also used as an ointment.

Modes of administration of mercurials.—(1) **By the mouth.**—The Liquor Hydrargyri Perchloridi is often given to adults, usually in doses of 1 to 2 fl. dr. (4 to 8 mils). For the later symptoms of syphilis, potassium iodide is often combined with it. Periodide of mercury is formed and is kept in solution by the excess of potassium iodide. Mercurous iodide, or the green iodide of mercury (p. 213), is much used by some. It is insoluble in water and is incompatible with potassium iodide, the red iodide and metallic mercury being formed. The best preparation for children is $\frac{1}{2}$ to 1 gr. (3 to 6 centigrms.) of grey powder, given just often enough to avoid purgation, and 1 to 2 gr. (6 to 12 centigrms.) three times a day

is often given to adults. Zittman's decoction (Decoctum Zittmanni B.P.C.) containing sarsaparilla, anise fruit, fennel fruit, senna leaves, liquorice root, calomel, cinnabar, alum, sugar and water, dose 3 to 6 fl. oz. (90 to 180 mils) is sometimes given.

(2) **By the rectum.**—Occasionally mercury is given as a suppository.

(3) **Endermically.**—Mercurials, especially calomel, are often dusted on sores and ulcers, and lotions are also locally applied. Mercury can be absorbed in this way.

(4) **By inunction.**—Blue ointment may be rubbed into the skin. Usually a piece the size of the top of the thumb (about 60 gr. or 4 grms.) is rubbed in once a day by the ungloved hand. The part of the body should be varied daily: the calves, inner side of the thighs, abdomen, arms, are suitable situations, hairy parts should be avoided. The daily duration of the rubbing is 20 minutes. The ointment has been put inside the sock, for then it is rubbed into the foot during walking. A very efficient way of applying it in children is to smear it on a flannel binder which is worn round the abdomen. The oleate may be employed for inunction. Inunction is one of the best means of insuring the absorption of mercury, but many patients object to such a tedious and dirty process and left to themselves perform it very inefficiently. Inunctions should be given on about 50 consecutive days and then after an interval resumed.

(5) **Intramuscularly.**—One-eighth of a grain (8 milli grms.) or less of the perchloride dissolved in 5 to 8 ♏ (30 to 50 centimils) of distilled water with a trace of sodium chloride may be used for a dose. The needle of a hypodermic syringe is plunged deeply into some muscles, preferably those of the gluteal region, and to the outer side of it, so that the patient does not sit or lie on the spot, and the required dose of the perchloride solution is injected. The injection should be repeated daily. Before going to bed is a good time. With proper care no abscesses result. This is a very rapid and thorough way of bringing the patient under the influence of mercury. Mercuric lactate (dose, $\frac{1}{4}$ to $\frac{1}{2}$ gr.) and mercuric cyanide (dose, $\frac{1}{20}$ to $\frac{1}{10}$ gr.) are good salts for intramuscular injection.

Mercury is, however, best given intramuscularly, as above directed, in the metallic form, for then only one injection weekly is required. Lambkin advises the following: mercury, $\frac{1}{2}$ oz. (16 grms.); lanolin, 2 oz. (64 grms.); carbolized liquid paraffin, ad 5 oz. (160 grms.). This equals gr. i. in ♏x. (6

centigrms. in 60 centimils). There are many other formulæ for oils and creams of mercury for intramuscular injection, *e.g.* Oleum Cinereum (Grey Oil) B. P. C., whichever is used the patient if under average weight should receive 1 gr. (6 centigrammes), if over average weight 1½ gr. (9 centigrammes) of mercury once a week for six weeks, then there should be eight weeks' rest, then intramuscular injections should be resumed, and these should alternate with rests so that 40 to 50 gr. are given in two years. If calomel is used the dose is ½ gr. (3 centigrms.). However mercury or its salts are given, administration for two years is necessary to efficiently treat syphilis. The inunction and intramuscular methods are the best. The teeth and mouth must be kept clean to avoid salivation.

(6) **Fumigation.**—Calomel is used. The patient, who is naked, sits on a cane-bottom chair; a blanket, which reaches to the floor, is fastened lightly round his neck. Twenty grains of calomel are placed in a porcelain dish over a spirit lamp under the chair. The calomel volatilizes, and is absorbed by the skin. A bath should last twenty minutes; with obvious modifications this method may be applied to patients in bed.

(7) **Inhalation.**—This is rarely or never used.

(8) **Baths** of 180 grains of the perchloride to thirty gallons of water, with one fluid drachm of hydrochloric acid added, have been used, but they are very rarely employed.

Toxicology.

Acute poisoning is rare. Salts of mercury, especially the per-salts, produce severe gastro-intestinal irritation, causing great pain, vomiting, and diarrhœa. Corrosive sublimate and white precipitate are the preparations usually taken. Acute poisoning has followed washing out large cavities with solutions of perchloride of mercury.

Chronic poisoning by mercury or its salts produces a train of remarkable symptoms. They were very common when it was the practice to give larger doses of mercurials than are now employed, and they are occasionally seen in those who work in mercury. In the present day, when the patient shows any sign of mercurialism, the dose is reduced. These symptoms (which constitute hydrargyrism or mercurialism) may be brought about however the mercury is taken. The first indications noticed are slight fœtor of the breath and soreness of the gums when the teeth are knocked. Then follows a disagreeable metallic taste in the mouth, the gums become swollen and soft,

and they bleed readily. Next there is a considerable increase in the amount of saliva secreted. All these symptoms gradually become more marked, and the tongue swells. The teeth are now loose, the saliva, which is thick and viscid, pours over the mouth, the parotid and salivary glands are enlarged and tender, and there is a slight rise of temperature. In olden days these symptoms occasionally ended in the falling out of the teeth, extensive ulceration of the mouth and tongue, necrosis of the jaw, great weakness, emaciation, anæmia, a watery state of the blood, a liability to hæmorrhages, exhaustion, and death.

More rarely the symptoms are, for the most part, nervous. These occur chiefly, if not entirely, among those who work in the metal and inhale the vapour. The first to be observed is tremor, beginning in the face, then invading the arms, and afterwards the legs. Early in the case the trembling is seen only on movement; soon it is permanent. It resembles paralysis agitans. Usually there is considerable weakness of the affected muscles ("mercurial palsy"). There may be pains, and a weak mental condition is common. Nothing has been found, post mortem, to account for these symptoms.

GROUP VII.

Arsenic, Antimony, Chromium.

The compounds of these metals have several physiological and some chemical points in common. The oxide of each is externally a powerful caustic. Internally, arsenic, antimony, and (as far as we know) chromium compounds are severe gastro-intestinal irritants. Arsenic and antimony in large doses both cause general fatty degeneration.

ARSENIUM.

Metallic Arsenic. Symbol, As. Atomic weight, 74·96.
(Not official.)

1. Acidum Arseniosum.—Arsenious Anhydride contains not less than 99·8 per cent. of arsenious oxide, As_4O_6. *Synonyms.*—Arsenic; Arsenious Acid; White arsenic.

Source.—Arsenical ores are roasted and purified by sublimation.

Characters.—A heavy white powder, or stratified opaque white masses. The strata are caused by the presence, in separate layers, of the crystalline and opaque, and of the amorphous and vitreous allotropic modifications of arsenious

anhydride. *Solubility.*—1 in 100 of cold, 1 in 10 of boiling water. When volatilized and sublimed, it forms minute, transparent, brilliant octahedral crystals. When heated with charcoal it gives off a garlic-like odour.

INCOMPATIBLES.—Lime water, salts of iron, magnesia.

IMPURITIES.—Lime salts.

Dose, $\frac{1}{64}$ to $\frac{1}{16}$ gr.—1 to 4 milligrms.

Preparations.

1. Liquor Arsenicalis. *Synonym.*—Fowler's solution. Arsenious acid, 10; potassium carbonate, 10; boil in 500 of water, and add compound tincture of lavender, 30; water, 500. No decomposition occurs, but an alkaline solution of arsenious acid is formed. *Strength.*—1 gr. of arsenious acid in 110 ♏, 1 grm. in 100 millilitres, or 1 per cent.

Dose, 2 to 8 m.—12 to 50 centimils.

2. Liquor Arsenici Hydrochloricus.—Arsenious acid, 10, is boiled with hydrochloric acid, 12, and water, 1000. No decomposition occurs, but an acid solution of arsenious acid is formed. *Strength.*—1 gr. of arsenious acid in 110 ♏, 1 grm. in 100 millilitres, or 1 per cent.

Dose, 2 to 8 m.—12 to 50 centimils.

2. Sodii Arsenas Anhydrosus. — Sodium Arsenate, Disodium Hydrogen Arsenate. Na_2HAsO_4 (Arseniate of Sodium, B. P. 1885; Sodii Arsenas, B. P. 1898).

SOURCE.—Expose to a temperature of 150° crystallized sodium arsenate, which may be prepared by treating with water the product of the fusion of arsenious anhydride with sodium nitrate and sodium carbonate.

CHARACTERS.—A white powder. The hydrous form, which contains seven molecules of water of crystallization, is often seen, and was official in B. P. 1885.

SOLUBILITY.—1 in 6 of water. The solution is alkaline.

Dose, $\frac{1}{40}$ to $\frac{1}{10}$ gr.—1·5 to 6 milligrms.

Preparation.

Liquor Sodii Arsenatis. *Strength.*—1 per cent. of anhydrous sodium arsenate in distilled water. It contains about half as much metallic arsenic as Liquor Arsenicalis.

Dose, 2 to 8 m.—12 to 50 centimils.

3. Arsenii Iodidum.—Arsenious Iodide. AsI_3.

SOURCE.—Made by the direct union of iodine and metallic arsenic.

CHARACTERS.—Small orange-coloured crystals or crystalline masses. Soluble in water and in alcohol. Solution neutral.

Dose, $\frac{1}{20}$ to $\frac{1}{5}$ gr.—3 to 12 milligrms.

Preparation.

Liquor Arsenii et Hydrargyri Iodidi. *Synonym.*—Donovan's solution. *See* Mercury, p. 213.

ACTION OF ARSENICAL COMPOUNDS.

External.—Arsenious acid has no action on the skin, but applied to raw surfaces it is a powerful caustic.

Internal.—*Alimentary canal.*—Unless the dose is very small, all preparations containing arsenic are very severe gastro-intestinal irritants (see Toxicology). Part at least of this effect is due to excretion of the arsenic into the stomach after absorption, for if given subcutaneously there may be no local effect, although there is intense gastritis soon after injection. In minute doses they are gastric stimulants, causing dilatation of the gastric vessels and an increased flow of gastric juice. Small doses also stimulate the duodenum.

Blood.—Arsenic is quickly absorbed into the blood, and is found especially in the polymorphonuclear white corpuscles. It cannot in health, but can in some forms of anæmia, increase the hæmoglobin and the number of red corpuscles; how it does this is unknown. Arsenic given during hæmorrhage has little effect on the blood, but if combined with iron it maintains the hæmoglobin even more than iron alone. It may cause brown pigmentation of the skin, and then the depth of pigmentation appears to be proportionate to the increase in the red corpuscles.

Bone.—In animals arsenic slightly stimulates the formation of compact bone. In small repeated doses it increases the leucoblasts but not the erythroblasts of marrow, it dilates the vessels and leads to atrophy

of the fat. In doses large enough to cause general emaciation the marrow undergoes hyaline degeneration. All these changes occur with many other drugs and are not peculiar to arsenic.

Circulation.—In the frog the rapidity and force of the heart are lessened till it finally stops. This is a local action, for it takes place when applied to the excised heart. Large doses destroy the capillaries and lead to hæmorrhage.

Remote effects.—In many diseases arsenic evidently profoundly affects metabolism, for the patient recovers under treatment by this drug. If given in small doses to healthy persons it usually improves the general condition, probably by increasing metabolism, but perhaps only by sharpening the appetite. It has been incorrectly stated to unite with albumen; another view, that of Binz and Schulz, is that arsenious acid becomes arsenic acid by taking oxygen from the protoplasm, but that the arsenic acid subsequently yields up the oxygen again and that the activity of arsenic is due to its being a carrier of oxygen. It makes the skin glossy. Some of the people in Styria eat white arsenic in small quantities, and it increases their strength, weight, and appetite and clears their complexion. It is probable that the reason why these people can take arsenic in such quantities is that an antitoxin is developed in them. Wood concludes that small doses of arsenic check tissue change and decrease nitrogenous elimination. Large doses certainly have the opposite effect, and cause fatty degeneration, especially of the liver, stomach, and intestines; the glycogen disappears from the liver, and the alkalinity of the blood falls owing to the formation of lactic acid. But our knowledge of the influence of arsenic on nutrition is very imperfect, nor do we know of any action to which its beneficial effects in many diseases can be referred, but as the drug certainly in some way alters the condition of the sufferer it is vaguely called an

alterative. It is eliminated chiefly by the urine, to a less extent by the alimentary canal, the sweat, the saliva, the bile, the milk, hair, cutaneous epithelium, and even the tears, but it is also stored in the body, chiefly in the liver and kidneys. It may be found many years after death in the bodies of those who have taken it during life. It can pass from the mother to the fœtus.

Excretion.—Most of it is excreted by the urine and fæces. Minute amounts pass out by the mucous membrane of the lungs, and by the skin.

THERAPEUTICS OF ARSENICAL COMPOUNDS.

External.—Formerly arsenious acid was used as a caustic to destroy growths, lupus, warts, &c., either pure or as a paste. It must be used strong enough to make the mass of dead tissue slough out quickly, or else the patient becomes poisoned, for the arsenic is rapidly absorbed. Liquor Arsenicalis has been recommended by Ringer as an application for corns.

Internal.—*Alimentary canal.*—Arsenious acid is useful to destroy the tooth pulps before stopping teeth.

In some forms of dyspepsia small doses of the Liquor Arsenicalis are occasionally given to stimulate the appetite. Arsenic is so liable to cause sickness, diarrhœa, and other symptoms of poisoning that it is a rule always to begin a course of it with small doses, say 3 or 4 ♏ (18 to 25 centimils) of the Liquor Arsenicalis, or $\frac{1}{60}$ to $\frac{1}{40}$ gr. (1 to 1·5 milligrms.) of arsenious acid as a pill, and gradually to increase the quantity. Arsenic in any form should always be taken immediately after meals, so as to dilute it by the contents of a full stomach. Children bear it well, old people do not. Very small doses sometimes check vomiting, especially that form in which the food simply regurgitates, and in exceptional cases it may succeed in checking diarrhœa when other drugs have failed.

Remote effects.—Arsenic is of great value in chronic superficial skin diseases not owing their cause to an irritant. It is therefore largely used for psoriasis, pemphigus, and sometimes for chronic eczema. It is of no use in the acute stages of these maladies, nor if cutaneous inflammation is deep-seated.

Cases of anæmia which cannot be cured by iron, and which fall under the heading of primary anæmia, may be much improved by arsenic. For these $\frac{1}{80}$–$\frac{1}{40}$ gr. (·7 to 1·5 milligrm.) of sodium arsenate dissolved in 10 ♏ (6 decimils) of water may be injected subcutaneously, but the drug is usually given by the mouth. Such are pernicious anæmia, splenic leucocythæmia, and Hodgkin's disease; but often no drug is of any avail. In other forms of anæmia, such as chlorosis, arsenic may be tried, but not often with benefit, when iron compounds disagree. It often improves the metabolism, the appetite, and the weight in those whose general health is feeble. Arsenic is, next to quinine, the best antiperiodic we have, but it is not nearly so efficacious. It may, however, in the absence of quinine, be used for ague, and is especially valuable for the anæmia which follows ague, and for neuralgia due to the same cause. It often does distinct good in rheumatoid arthritis if given for a long while. It is frequently prescribed for chorea, but it is difficult to prove that the cases get well more quickly than they would without any drug. Arsenic has been strongly recommended in asthma and in hay fever. For asthma it may be given by the mouth, or smoked as cigarettes, made by saturating bibulous paper in a solution of fifteen grains of potassium arsenite to an ounce of water. It has been given in phthisis, but without benefit. If taken with thyroid preparations it appears to diminish the liability to thyroidism. The springs of Levico and La Bourboule contain arsenious acid. The waters are sold in England, and

form a convenient way of giving the drug. Strong Levico contains $\frac{1}{12}$ gr. arsenious acid and 30 grains of iron salts in a pint. Weak Levico contains $\frac{1}{120}$ and 8 gr. respectively. La Bourboule contains $\frac{1}{12}$ gr. arsenious acid and a trace of iron to the pint. These waters should be drunk at meals.

Cacodylates. (Not official.)—Arsenic has been much given in the form of cacodylate of sodium (the sodium salt of cacodylic acid $(CH_3)_2AsOOH$).

Dose, $\frac{1}{2}$ to 1 gr.—30 to 60 milligrms.

The drug contains 61·8 per cent. of arsenious acid, and yet it is stated that large doses of it do not cause poisoning; this is because arsenious acid is very slowly formed from it within the body, and possibly much of the cacodylate is got rid of before this happens. It has not been conclusively shown to be therapeutically superior to arsenious acid. It is often given hypodermically, $\frac{3}{4}$ gr. (45 milligrms.) in 15 ♏ (1 mil) of water daily.

Sodium Aminophenylarsonate. (Not official.) (*Synonyms.*—Sodium aminarsonate, atoxyl, soamin, arsamin.) A white crystalline powder, soluble 1 in 6 of water.

Dose, 1 to 3 gr.—6 to 20 centigrms.—by mouth or hypodermically dissolved in water. Even 15 gr. (1 grm.) has been given for a single dose.

This compound of aniline and arsenious acid contains about 24 per cent. of metallic arsenic, but much larger doses of it than of ordinary arsenical preparations can be given without symptoms of poisoning. Lately it has been given both alone and combined with mercurials for malaria, relapsing fever and epidemic cerebrospinal meningitis, but it has not yet been shown to definitely cure, although it often benefits. It is efficacious, especially when tartar emetic is also given, for trypanosomiasis. Precisely how it acts is not known; it does not affect trypanosomes outside the body. Many cases of poisoning are on record; the symptoms are dryness of the throat, headache, vomiting, diarrhœa, and in some cases total blindness due to optic atrophy. Injections are given subcutaneously—rarely intravenously—at intervals of 2 or 3 days.

Sodium Acetarsenate. (Not official.) (*Synonym.*—Arsacetin) is synthetised from atoxyl by the introduction of an acetyl radicle, may be used in the same doses as atoxyl, and has the great advantage of being less toxic. It has been suggested that full doses of atoxyl or arsacetin drive the trypanosomes out of the blood. Solutions of arsacetin keep better and bear being sterilised better than those of atoxyl.

Arsenobenzol. (Not official.) *Synonyms.*—Kharsivan. Salvarsan. Arsenobillon. It is chemically dioxydiamino-arsenobenzol dihydrochloride. It is often called "606" because that was its number in a series investigated. Salvarsan is a German trade name and therefore it is difficult to obtain under this name, but it can be obtained under its other names.

CHARACTERS.—A bright yellow powder slowly but completely soluble in water. Strongly acid, contains 34·15 per cent. arsenic. Supplied in glass tubes filled with an inert gas to prevent oxidation. The tube should not be opened until immediately before administration.

Dose, 0·3 to 0·6 gramme. The amount usually contained in each tube is 0·6 grm. Mostly given intravenously but not now so much used as Novarsenobenzol intramuscularly. 100 c.c. of hot, sterile, freshly-distilled water are put in a sterilized glass vessel. Into it the salvarsan is slowly shaken and dissolved, by stirring with a glass rod. Add 4 per cent. sodium hydrate solution. A precipitate forms, and, as the solution is slowly added, it redissolves. When this happens, make up the total bulk to 200 c.c. with warm normal saline, made with freshly-distilled water. Inject the fluid into a vein at the bend of the elbow with any of the various apparatus at such a temperature that when it enters the vein it is about 100° F. (38° C.). The patient should be in bed for 24 hours before injection. During this time he should have his bowels well opened, and have only light diet. During injection he should be recumbent, and must remain in bed, on light diet, for 24 hours after injection. The operation must be strictly aseptic. Often there is soon after it slight pyrexia for a few hours; but severe symptoms—as considerable pyrexia, rigors, vomiting, and diarrhœa—can be avoided if every one of the above details is observed, especially the use of freshly-distilled water; for after distilled water has remained in the laboratory some time bacteria appear in it, and even if then sterilized before use, it contains the dead bodies of them, and it is these dead bacteria which are thought to be the cause of the pyrexia and other symptoms which used often to follow the use of salvarsan.

When given intramuscularly, the dose of salvarsan is shaken into 10 c.c. of warm distilled water; 6 c.c. of 4 per cent. sodium hydrate solution is added, and then 6 per cent. acetic acid till the mixture is just acid; then a drop of sodium hydrate solution is added, so that when injected it is just alkaline. It is then injected intramuscularly into the gluteal region, or into the scapular muscles. Occasionally this leads

to a painful swelling, and then intravenous injection is to be preferred to intramuscular. It should never be given subcutaneously. For further details special works must be consulted.

Novarsenobenzol. (Not official.) *Synonyms.*—Neosalvarsan, Novarsenobillon, Neokharsivan.—A condensation product of formaldehyde sulphoxylate of sodium and salvarsan. Known as No.914. A yellow powder. It is as efficacious for syphilis as salvarsan, and has the great advantage of being freely soluble in water, forming a neutral solution. 1·5 grm. neo-salvarsan equals 1 grm. salvarsan. A usual dose is 1 grm. dissolved without heating, and with very little shaking, in 200 c.c. of freshly distilled water, given intravenously. It is often given intramuscularly, and is the best preparation for this purpose causing less pain and being more quickly absorbed than "606." The dose is 0·6 grm. injected into the gluteal muscles. If the injection causes pain the drug may be dissolved in the syringe in 10 ♏ of distilled water and made up to 2 c.c. with creocamph. Sometimes an injection of morphia is necessary to relieve the pain. Many observers believe that this is the best way to give these arsenical preparations for syphilis, for when given intravenously they are perhaps excreted too quickly. Further, the intramuscular method is much easier than the intravenous.

Galyl. (Not official.) Tetraoxydiphosphaminodiarsenobenzene. A synthetic substitute for salvarsan. It is a yellow powder given in just the same way as neosalvarsan. The usual dose, 0·4 grm., corresponds to 0·9 grm. of neosalvarsan. Galyl appears to be as efficacious in the treatment of syphilis, and ill-effects are very rare.

Action and Therapeutics.

A syphilitic chancre, a secondary syphilide or ulceration, or a tertiary gumma or ulceration generally improves extraordinarily rapidly after a dose of arsenobenzol, novarsenobenzol, or galyl. Syphilitic lesions that have been chronic for months will disappear in a few days. These drugs are of use in acquired or congenital syphilis; they cannot restore structures already destroyed, but will prevent the progress of the syphilis. Their use causes the spirochetes to disappear and the Wassermann reaction usually becomes negative. They probably act, after being changed in the body, by altering the

tissues of the patient chemically so that they are able to kill the spirochetes. Sometimes transient pyrexia follows; very rarely severe and even fatal conditions occur later. Such are encephalitis hæmorrhagica, hæmorrhagic nephritis, dermatitis and jaundice. After a usual dose arsenic may be found in the urine up to the eighth day. If the patient is suffering from any serious organic disease other than his syphilis, and especially if his kidneys are diseased, these drugs should either be withheld or given carefully in small doses. Sufficient time has not yet elapsed for us to be sure that syphilis is permanently cured by them, and it is wise also to give a two or three years' course of mercury (p. 223). Usually four to eight doses of arsenobenzol, novarsenobenzol, or galyl are given at intervals of a week; some give weekly intramuscular injections of mercury at the same time, others do not begin the mercury till the completion of the first arsenical course, which is after a rest repeated more than once for a shorter time, and arsenic and mercury are thus given for a year or even two or three years. All three have been used for pernicious anæmia, half the doses employed for syphilis being given intramuscularly. Arsenobenzol (0·1 grm., water 30 ♏ (2 mils), glycerin ½ fl. oz., 15 mils) has been used with benefit as a local swab for chronic ulcerations of the mouth.

TOXICOLOGY.

Acute Poisoning.—White arsenic is frequently used as a poison. Soon after taking it the sufferer experiences faintness, nausea, sickness, epigastric pain and tenderness. These symptoms quickly increase. The vomit is brown, and often streaked with blood; the pain is very severe; there is profuse diarrhœa, with much tenesmus; and there are cramps in the calves of the legs. The vomiting becomes violent and incessant; there is a burning sensation in the throat, with intense thirst. Soon severe collapse sets in; the skin is cold, the pulse small and feeble, and the patient dies collapsed. The symptoms frequently bear a close resemblance to those of cholera. *Post mortem.*—The stomach is intensely inflamed, even if the arsenic has not been taken by the mouth, but has

been applied in large quantities to cancerous growths. This shows that arsenic is excreted from the blood into the stomach. The small intestines are also acutely inflamed.

Treatment.—Wash out the stomach. Give emetics (p. 145), choosing the least irritating and least depressing. The stomach must be completely emptied. Give unlimited quantities of freshly prepared humid peroxide of iron (p. 204) or dialysed iron (p. 204). If neither of these is handy, give magnesia in large amounts, or large doses of castor oil and water. Give brandy or ether subcutaneously; apply hot blankets and bottles to the feet and the abdomen.

Chronic Poisoning.—Often, when arsenic is taken as a medicine, slight symptoms of poisoning are seen. They are loss of appetite, nausea, perhaps vomiting, slight abdominal pain, and mild diarrhœa. The eyelids become a little puffy, the conjunctivæ injected, the eyes and nose water, and there is slight headache. These symptoms, of course, show that the dose given is too large, and that it must be decreased.

Arsenic is so often used in the manufacture of all sorts of articles, especially wall papers and fabrics, that chronic poisoning by it is frequently seen. It is also met with in workers in arsenic, and in persons to whom it has been given with intent to murder. The symptoms produced are those already mentioned as present when large doses of arsenic are taken medicinally.

Long-continued use of arsenic may induce peripheral neuritis; the chief symptoms of arsenical neuritis are herpes zoster, paralysis of the muscles of the limbs, especially the extensors of the hands and feet, ataxic gait, severe darting pains in the limbs, and rapid muscular atrophy. Several cases are recorded in which arsenic has caused general brown pigmentation of the skin, best marked about the neck. Very rarely pigment forms in the mucous membrane of the mouth. It may also give rise to a general increase of epidermic scales (keratosis) and to brown pigmentation of patches of psoriasis, and in quite exceptional cases cause eczema or urticaria. The tongue may be silvery. After death from chronic poisoning, in addition to the gastro-intestinal and nervous lesions, there is widespread fatty degeneration of most of the organs of the body. It is well seen in the liver, kidneys, stomach, and muscles, including the heart.

Repeated doses given to animals abolish the glycogenic function of the liver, and puncture of the floor of the fourth ventricle no longer causes glycosuria. In frogs poisoned with arsenic the epidermis peels off very easily. This is due to degeneration of its lower cells, the degeneration proceeding from the lowest layer outwards.

ANTIMONIUM.

Antimony. Symbol, Sb. Atomic weight, 120·2.
(Not official.)

1. Antimonium Sulphuratum.—Sulphurated Antimony. A mixture of antimony sulphides and oxides.

SOURCE.—Boil antimonious sulphide with sublimed sulphur and a solution of soda, and precipitate with sulphuric acid.

CHARACTERS.—A dull-red powder, insoluble in water.

Dose, 1 to 2 gr.—6 to 12 centigrms.

Contained (1 part in $4\frac{1}{3}$) in Pilula Hydrargyri Subchloridi Composita.

2. Antimonii Oxidum.—Antimonious Oxide. Sb_4O_6.

SOURCE.—Pour a solution of antimonious chloride into water. The precipitated oxychloride is treated with sodium carbonate, and the result washed and dried.

CHARACTERS.—A greyish-white powder, insoluble in water.

Dose, 1 to 2 gr.—6 to 12 centigrms.

Preparation.

Pulvis Antimonialis.—A substitute for "James's powder." Antimonious oxide, 1; calcium phosphate, 2.

Dose, 3 to 6 gr.—2 to 4 decigrms.

3. Antimonium Tartaratum.—Tartarated Antimony, or Potassio-tartrate of Antimony. $(KSbO,C_4H_4O_6)_2$, H_2O. *Synonym.*—Tartar emetic.

SOURCE. Prepared from antimonious oxide and acid potassium tartrate, made into a paste with water until combination has taken place, and purifying by crystallization.

CHARACTERS.—Colourless transparent crystals with triangular facets. *Solubility.*—1 in 17 of cold, 1 in 3 of boiling water. The solution is faintly acid.

INCOMPATIBLES.—Gallic and tannic acids, most astringent infusions, alkalies, lead salts.

IMPURITY.—Acid tartrate of potassium.

Dose, $\frac{1}{25}$ to $\frac{1}{8}$ gr.—2·5 to 8 milligrms.; $\frac{1}{2}$ to 1 gr. (emetic)—**3 to 6 centigrms.**

Preparation.

Vinum Antimoniale. Tartarated antimony, 4; boiling distilled water, 40; sherry, to make 1000.

Dose, 10 to 30 m.—6 to 18 decimils, 2 to 4 fl. dr.—8 to 16 mils, as an emetic.

Action.

External.—Antimonial compounds are powerful external irritants. Tartar emetic produces a pustular eruption at the point of application.

Internal.—*Alimentary canal.*—All compounds of antimony are powerful irritants, internally as well as externally; the action of tartar emetic is best known. The first result of swallowing this is vomiting. The early acts of vomiting are entirely due to the direct action of the drug on the wall of the stomach, but after it is absorbed, by its action on the medulla it also produces sickness; but this action is slight. It will cause vomiting when injected into the blood, a little by its action on the medulla—for it will act if the stomach is replaced by a bladder—but chiefly because some of it is excreted into the stomach and intestines, and thus the vomiting is continued for some time. In large doses tartar emetic is irritant to the intestine.

Heart.—Antimony acts upon man as upon the lower animals. It is a powerful cardiac depressant, diminishing both the frequency and the force of the beat of the heart. Experiments on animals have shown that the final stoppage takes place in diastole, and that the chief action of antimony is that of a direct depressant to the cardiac muscle itself. Of course the cardiac depression causes the arterial pressure to fall, but part of this effect is due to a coincident action upon some portion of the vaso-motor system; the probability being that antimony, paralysing the muscular coat of the arteries, relaxes them.

Respiration.—Respiration is depressed, the movements become weaker, and inspiration is shortened, but expiration is prolonged. Finally, the pauses become very long and the movements very irregular.

Nervous and muscular systems.—Here also antimony acts as a powerful depressant, especially to the spinal cord, and to a less extent to the brain; hence

moderate doses cause a feeling of languor, inaptitude for mental exertion, and sleepiness. Experiments on animals show that after the administration of large doses of antimony reflex movement is soon lost, and that this is due to a depressing effect on the sensory part of the spinal cord. This depressant influence is felt also in the muscles, and hence antimony will relieve spasm.

Temperature.—Moderate doses hardly affect the temperature, but large doses cause a considerable fall, owing, no doubt, in the main to the circulatory depression. These depressant effects on the heart, respiration, and temperature are largely due to the vomiting, for although antimony is a general depressant after absorption, it is slowly absorbed.

Excretion.—Antimony is excreted by the urine, bile, sweat, bronchial secretion, milk, and particularly by the fæces. We have seen that part of its emetic effect is due to its excretion into the stomach. As it passes out by the bronchial mucous membrane it increases the amount of secretion, and thus acts as an expectorant. On the skin its action is that of a profuse diaphoretic. This is chiefly a secondary result of the depression of the circulation, but it is possibly in part a direct local effect. In frogs the action on the skin is very like that of arsenic, but antimony softens rather than detaches the epidermis, which thus becomes a jelly-like mass. Being excreted in the bile, it perhaps aids its flow; therefore it may be a cholagogue.

In passing through the kidneys it may be slightly diuretic, but this depends upon the amount of perspiration produced by it. If its use is continued for some time it will cause, like arsenic, fatty degeneration, especially of the liver, and abolition of the hepatic glycogenic function.

THERAPEUTICS.

External. — Formerly an ointment of tartar emetic was commonly applied as a counter-irritant.

Internal.—*Alimentary canal.*—Tartar emetic is not to be recommended as an emetic, for the action is slow, and the general depression of emetic doses is great. For this reason it should never be given to produce purgation. Some years ago it was given if an emetic was required for laryngitis, bronchitis, or any acute inflammatory condition of the respiratory tract, but usually ipecacuanha is preferable.

Circulation.—Antimony was formerly largely employed, especially in combination with aconite, to reduce the force and frequency of the pulse in all sorts of febrile conditions, but this is now generally thought unnecessary. If it is to be used it is especially indicated in respiratory affections, for then its expectorant effect may be valuable.

Respiration.—It has been very much given for the early stage of acute bronchitis, but certainly it should not be continued after a free secretion of bronchial mucus has been set up by it. After that it is, on account of its depressing influence, an undesirable expectorant.

Nervous and muscular systems.—Its use as a sedative in delirium tremens is now abandoned, and the introduction of chloroform has made it unnecessary to employ tartar emetic to relax muscular spasm in herniæ and dislocations.

Remote effects.—Occasionally it is given in fevers for its diaphoretic influence, and for its slight antipyretic action. Sometimes it is ordered as a cholagogue, but because of its powerful depressant action it is less used as a medicine than formerly.

A 2 per cent. solution of tartar emetic given intravenously is useful for Kala-azar (Leishmaniasis). The first dose is 2 c.c., and 1 c.c. is added at each bi-weekly dose until 10 c.c. is reached. Bilharziasis

is successfully treated the same way by injecting 1 or 2 grs. for each dose till 30 grs. have been given, as is also trypanosomiasis when atoxyl is given at the same time. Tartar emetic intravenously is also useful for filariasis.

TOXICOLOGY.

Acute Poisoning.—The symptoms are very like those of arsenical poisoning (p. 234). *Post mortem.*—The gastro-intestinal irritation is very similar, but less marked.

Treatment.—Unless the vomiting is very free, apomorphine subcutaneously, or zinc sulphate by the mouth, or the stomach-pump may be used. Also frequent doses of half a drachm of tannic or gallic acid dissolved in water strong tea or coffee, mucilaginous drinks, and stimulants subcutaneously. Hot water bottles and warm blankets may be necessary.

Chronic poisoning is very rare.

CHROMIUM.

Symbol, Cr. Atomic weight, 52. (Not official.)

1. Acidum Chromicum.—Chromic Acid. Chromic anhydride. CrO_3.

SOURCE.—Prepared from potassium bichromate by the action of sulphuric acid.

CHARACTERS.—Crimson acicular crystals, very deliquescent, soluble in water. Readily yields oxygen, and will therefore easily explode. It does so with either glycerin or alcohol.

Preparation.

Liquor Acidi Chromici.—Chromic acid 25; water, to 100.

ACTION.

External.—In consequence of its oxidizing power chromic acid is a powerful deodorant and disinfectant. It coagulates albumen and oxidizes organic matter, and is therefore a powerful caustic.

Internal.—None is known.

THERAPEUTICS.

External.—As a lotion, 1 in 40, or even stronger, chromic acid has been used for its disinfectant properties to wash foul ulcers and sores, and also as

a local application for ozæna, gonorrhœa, leucorrhœa, and bad ulceration of the mouth, but a gargle should contain only a grain in a fluid ounce. The pharmacopœial liquor is occasionally used as a caustic to destroy condylomata.

2. Potassii Bichromas.—Potassium Bichromate. $K_2Cr_2O_7$.

SOURCE.—Prepared from chrome ironstone by roasting with lime in the presence of air, treating the resulting chromate with a potassium salt and subsequently with an acid.

CHARACTERS.—Large orange-red transparent triclinic crystals. *Solubility.*—1 in 10 of water.

INCOMPATIBLES.—Owing to the ease with which it oxidizes it readily forms explosive compounds. Hence it is best prescribed with kaolin or in capsules.

Dose, $\frac{1}{10}$ to $\frac{1}{5}$ gr.—6 to 12 milligrms.—in capsules, or as a pill with kaolin.

ACTION AND THERAPEUTICS.

Handling the salt frequently may produce eczema. Its solution is a very severe gastro-intestinal irritant. Potassium bichromate is said to be useful for gastric catarrh and gastric ulcer; it is best given on an empty stomach thrice a day.

The remaining groups of the inorganic drugs are non-metallic.

GROUP VIII.

Containing **Phosphorus** only.

PHOSPHORUS.

Symbol, P. Atomic weight, 31·04. (Official.)

SOURCE.—Obtained from calcium phosphate.

CHARACTERS.—A wax-like solid, freely soluble in carbon bisulphide, sparingly soluble in alcohol, ether, and chloroform, 1 in 80 in olive oil or melted fat, insoluble in water; luminous in the dark. Must be kept under water, as it oxidizes and takes fire very easily. Heated with hydrogen it forms red or amorphous phosphorus, which is non-poisonous, as it is so insoluble that it cannot be absorbed.

Dose, $\frac{1}{100}$ to $\frac{1}{25}$ gr.—0·6 to 2·5 milligrms.—in pill or solution.

Preparations.

1. Oleum Phosphoratum.—1 of phosphorus dissolved at 80°C. in 98 of almond oil, which must first be heated to 150°C. and filtered to remove water and organic matter, for this would otherwise oxidize the phosphorus; 1 of oil of lemon is finally added. This preparation is very nasty. *Strength.*—1 per cent.

Dose, 1 to 5 m.—6 to 30 centimils (in a gelatin capsule).

2. Pilula Phosphori.—Phosphorus, 1; oil of theobroma, 40; wool fat, 11; kaolin, 16; sodium sulphate, 32; carbon disulphide, 20. *Strength.*—1 per cent. of phosphorus.

This pill should be freshly prepared. It is one half the strength of the corresponding pill B. P. 1898.

Dose, 1 to 4 gr.—6 to 25 centigrms.

Action.

The only known action of minute doses of phosphorus is that in animals the spongy tissue of the bones is thickened by the deposition of true bone of normal composition, and the compact tissue is rendered more dense. If rather larger, frequently repeated doses are given for some time, proliferation of the interstitial connective tissue of the stomach, liver, and kidney is also found. With still larger doses fatty degeneration is produced, as described under Toxicology. Phosphorus enters the blood as phosphorus, and acts as such, not as phosphoric acid. It is eliminated in the urine as phosphates. Elixir Phosphori (B. P. C.)—dose, 15 to 60 m. (1 to 4 mils)—is the best fluid preparation.

Therapeutics.

It has been used in osteomalacia, in rickets, and in cases of ununited fracture, but for rickets at least it is a very inferior remedy, and it is probably of little use in medicine.

Toxicology.

Acute Poisoning.—Phosphorus is often taken, or administered criminally, either as match heads or vermin paste. For the first few hours there are no effects, then the following symptoms of gastro-intestinal irritation set in:—Nausea, abdominal pain, and vomiting; the vomited matters smell of phosphorus and are luminous. There is some general depression. Diarrhœa is rare. The patient may die of collapse, but far more frequently these symptoms all pass off, and he appears quite well. But after three or four days jaundice is noticed, and this soon becomes very deep; there is now great prostration, the liver is enlarged, the abdomen distended, and he complains of intense thirst. Vomiting of altered blood and diarrhœa with bloody stools may be observed, but these two symptoms are not severe. The skin is cold, the pulse feeble and rapid. The urine is scanty, highly coloured, albuminous, bile-stained, and perhaps bloody; it contains the acetone bodies and lactic acid, and in the final stages may contain bile acids and crystals of leucin and tyrosin. There is an excessive protein metabolism as shown by the increase of sulphates, phosphates, and nitrogen in the urine. This last comes from the excess of ammonia which is produced in the protein tissues and poured into the blood to neutralize the lactic acid and the acetone acids, which appear because phosphorus prevents the complete oxidation of glycogen, fat, and the non-nitrogenous results of protein breakdown. This incomplete oxidation leads to the accumulation of fat in the liver and the muscles which undergo fatty degeneration. Muscular twitchings occur, the patient becomes comatose and dies. *Post mortem.*—Two results are very striking. (1) Fatty degeneration (thus phosphorus resembles arsenic and antimony), affecting principally the liver, in which it is very marked; and if the patient lives long enough there may be a diminution in size of the organ. Fatty degeneration is also found in the muscles, kidneys, and gastro-intestinal tract. (2) Hæmorrhages are seen in many places, and ecchymoses are sometimes very abundant. If they occur in the gastric and intestinal mucous membranes they may give rise to the erroneous belief that evidences of acute gastro-intestinal irritation can be found at death. The symptoms of phosphorus poisoning in many respects resemble those of acute yellow atrophy of the liver.

Treatment.—Thoroughly empty the stomach by a stomach-pump or by washing it out. Give copper sulphate as an emetic (*see* p. 184), three grains (2 decigrms.

every few minutes till vomiting is induced, then every 15 minutes; also half a drachm of oil of turpentine (*q.v.*) every half-hour. A full dose of a saline purge may be administered. No other oils or fat should on any account be given.

Chronic Poisoning.—This, which used to be seen in those who worked among phosphorus fumes, is now of great rarity. The chief symptoms are those of gastro-intestinal irritation and necrosis of the jaw. This Stockman has shown to be due to the fact that the phosphorus fumes, when the gum is broken, gain access to the bone and lower its vitality, so that it easily becomes the seat of tubercular disease. Sufferers from phosphorus necrosis often die from general tuberculosis.

1. Calcii Hypophosphis.—Calcium Hypophosphite. $Ca(PH_2O_2)_2$.

SOURCE.—Heat phosphorus with slaked lime and water.

CHARACTERS.—White pearly crystals, with a bitter nauseous taste. *Solubility.*—1 in 8 of cold water.

Dose, 3 to 10 gr.—2 to 6 decigrms.

2. Sodii Hypophosphis.—Sodium Hypophosphite. $NaPH_2O_2$.

SOURCE.—Add sodium carbonate to a solution of calcium hypophosphite and evaporate.

CHARACTERS.—A white granular salt with a bitter taste. *Solubility.*—1 in 1 of water.

Dose, 3 to 10 gr.—2 to 6 decigrms.

THERAPEUTICS OF HYPOPHOSPHITES OF CALCIUM AND SODIUM.

These drugs have been recommended for phthisis, but although in some cases they appear to have done good there is no satisfactory evidence of their value. Hypophosphite of iron is often prescribed (dose, 1 to 5 gr., 6 to 30 centigrms., slightly soluble in water). All three hypophosphites are best given dissolved in water and syrup. The Syrupus Hypophosphitum Compositus (B. P. C.), dose $\frac{1}{2}$ to 2 fl. dr. (2 to 8 mils), contains those of iron, potassium, quinine, calcium, and manganese, together with $\frac{1}{160}$ gr. (0·4 milligrm.) of strychnine in each drachm. This is a popular general tonic. It should be remembered

that hypophosphites explode if heated. Calcium Lactophosphate is described on p. 163.

Glycerophosphates.—(Not official.)

Calcii Glycerophosphas (dose, 3 to 10 gr., 2 to 6 decigrms., soluble in water) is most used. Ferri Glycerophosphas (dose, 1 to 5 gr., 6 to 30 centigrms., sparingly but sufficiently soluble in water) is a useful salt. Glycerophosphates have been much given to persons who from overwork or disease are run down, weary, and easily tired, and certainly in some cases they are of benefit. They are best given in an ounce of water flavoured with syrup, and taken directly after meals thrice daily. Many other glycerophosphates, besides the above, are in the market. An excellent preparation is the Syrupus Glycerophosphatum Compositus (B. P. C.), dose 1 to 2 fl. dr. (4 to 8 mils). It contains glycerophosphates of calcium, potassium, sodium, magnesium, and iron, with citric acid, caffeine, and strychnine. There are in the market many preparations of casein associated with glycerophosphates. *Vitafer* is an example. The preparation *Sanatogen* is sodium glycerophosphate of casein. Tunnicliffe's researches appear to show that the phosphorus of glycerophosphates is absorbed and retained in the body.

GROUP IX.

Chlorine, Iodine, Bromine.

These elements, which are chemically so closely allied, are all of them powerful disinfectants and irritants.

CHLORINE.

Symbol, Cl. Atomic weight, 35·46.

This *gas is not official* under its own name, *but it is officially* obtained from chlorinated lime and chlorinated soda, and acidum nitro-hydrochloricum dilutum contains free chlorine.

1. Calx Chlorinata.—Chlorinated Lime. $CaCl_2O_2$, $CaCl_2$. *Synonym.*—Bleaching powder.

Source.—Pass chlorine gas over slaked lime.

Characters.—A dull white powder, smelling of chlorine, which it evolves on addition of an acid or on exposure to air, for it absorbs carbonic acid gas. Contains 33 per cent. of available chlorine.

Preparation.

Liquor Calcis Chlorinatæ.—1 of chlorinated lime shaken up with 10 of water Yields 3 per cent. of chlorine.

2. Liquor Sodæ Chlorinatæ.—Solution of Chlorinated Soda.

Source.—Mix a solution of sodium carbonate with one of chlorinated lime.

Characters.—A colourless liquid with an odour of chlorine. It is a mixture of chloride, hypochlorite, and carbonate of sodium. Contains 2·5 per cent. available chlorine. To be preserved in a cool, dark place.

Dose, 10 to 20 m.—6 to 12 decimils.

Action.

External.—Chlorine is one of the most powerful antiseptics, disinfectants, and deodorizers. Its antiseptic power is believed to be due either to its affinity for hydrogen or to its replacing this in proteins.

Internal.—Schäfer has shown that the inhalation of chlorine (even as little as 1 or 2 per cent. in air) causes a rapid fall of blood pressure, respiration becomes difficult and soon ceases. The lungs after death are red, the pulmonary vessels are gorged with blood, and there is severe œdema of the lungs. Death is due to obstruction of the pulmonary vessels. Many soldiers were gassed with chlorine by the Germans during the war. The symptoms were lividity, great difficulty of respiration, a failing pulse, and pouring of a pale brown fluid from the trachea. The physical signs were those of pulmonary œdema and bronchitis. Chlorine taken internally is converted into chlorides.

Therapeutics.

External.—Chlorine is largely used in the form of chlorinated lime to disinfect privies, drains, urinals, &c. It may be employed also to disinfect rooms after infectious diseases. All metals or articles, such as fabrics, likely to be bleached, should be covered up or removed; the windows and chimneys should be pasted up. The gas can be evolved from common salt, black oxide of manganese, and sulphuric acid. The

door is then shut, and the cracks around it are pasted over with paper. Chlorine water is sometimes employed as a wash for foul ulcers. Labarraque's solution is a solution of chlorinated soda one fourth the strength of the B. P. preparation. Eau de Javelle is a solution containing sodium hypochlorite; both these, liquor calcis chlorinatæ, liquor sodæ chlorinatæ, electrolysed salt solution and electrolysed sea water, are extremely valuable antiseptics, chiefly on account of the hypochlorites they contain, which, being decomposed by the tissues, liberate nascent chlorine. Dakins solution, which is a 0·45 to 0·5 per cent. solution of sodium hypochlorite, is used in surgery. A dusting powder (called Eupad powder) of equal parts of bleaching powder and boric acid is excellent for wounds, and so is irrigation of a solution of 1 in 1000 to 1 in 2500 of hypochlorite.

Eusol, used in surgery, is a filtered solution of 25 grms. of eupad in 1 litre of water. It contains 0·5 per cent. of hypochlorous acid, i.e. 0·27 grm. hypochlorous acid in 100 c.c. It has been injected intravenously for septicæmia, any benefit is due to its antitoxic action; it cannot in the blood have an antibacterial action, as it will be too dilute.

Chloramine-T (p. toluene-sodium-sulpho-chloramide) is used as a 3 to 4 per cent. solution for surgical work, as a 0·5 to 2 per cent. solution for a mouth wash or douche. The 2 per cent. oily solution is an excellent spray disinfectant for the nose for carriers of the meningococcus. Dakins solution, eusol and chloramine-T all act in virtue of their chlorine.

Internal.—A gargle (Gargarisma Chlori, B. P. C.), containing free chlorine is very useful for syringing and rinsing the fauces and nose in scarlet fever and other septic conditions. To make it put 200 gr. of potassium chlorate in a dry bottle, pour on 40 ♏ of hydrochloric acid, set aside, loosely corked for 10 minutes, then a pint of water in 4 or 5 successive

portions, shaking each time. It must be quite recently prepared and diluted with an equal part of water.

IODUM.

Iodine. Symbol, I. Atomic weight, 126·92. (Official.)

SOURCE.—Obtained from the ashes of seaweeds and from mineral iodides and iodates.

CHARACTERS.—Rhombic prisms or octahedrons, with a peculiar odour and dark colour, giving a violet vapour on heat. *Solubility.*—1 in 5000 of water; freely in alcohol (90 per cent.), ether, chloroform, or a solution of potassium iodide.

INCOMPATIBLES.—Metallic salts, mineral acids, alkaloids, oil of turpentine, and ammonia; with the last two explosive compounds may be formed.

Preparations.

1. **Tinctura Iodi Fortis.**—Iodine, 10; potassium iodide, 6; water, 10; alcohol (90 per cent.), to produce 100. *Strength.*—0·1 grm. of iodine in each millilitre; $\frac{1}{11}$ gr. in 1 ♏. This corresponds to Linimentum Iodi, B. P. 1885, and contains the same proportion of iodine as the Liquor Iodi Fortis, B. P. 1898.

2. **Tinctura Iodi Mitis.**—Iodine, 1; potassium iodide, 1; water, 1; alcohol (90 per cent.), to produce 40. *Strength.*—0·025 grm. in each millilitre; $\frac{1}{44}$ gr. in 1 ♏. This contains the same proportion of iodine as Tinctura Iodi, B. P. 1898.
Dose, 2 to 5 m.—12 to 30 centimils.

3. **Unguentum Iodi.**—Iodine, 1; potassium iodide, 1; glycerin, 3; prepared lard, 20. *Strength.*—4 per cent. of iodine. In India prepared suet should be used instead of prepared lard.

ACTION.

External.—The actions of iodine applied externally are the same as those of chlorine, that is to say, it is powerfully disinfectant and irritant. Iodine applied to the skin produces a yellow stain, which can be removed by an alkali or sodium hyposulphite. It also causes a sensation of heat and burning, dilatation of the vessels (rube-

faction), some œdematous swelling, and some exudation of leucocytes, to which its energetic absorbent action is partly due. There often is an accumulation of fluid under the epidermis forming a vesicle. Preparations of iodine are rarely used strong enough to produce more powerful irritation than this. The external application of them probably reflexly contracts the vessels of the subjacent organs, and this may explain their use as counter-irritants. If they are too strong, the irritation set up by them will proceed to the formation of pustules, and deep inflammation with scarring. They usually destroy the superficial cuticle, so that after the use of them the skin peels. Iodine may be absorbed from the skin, and the alkalies of the blood serum lead to the formation of sodium iodide and sodium iodate; thus

$$6NaHCO_3 + 3I_2 = 6CO_2 + 3H_2O + 5NaI + NaIO_3.$$

These, when they meet an acid, undergo double decomposition; thus

$$5NaI + NaIO_3 + 3H_2O = 6NaHO + 3I_2.$$

Thus free iodine is formed in the stomach and kidneys, and so if iodine has been applied to too large an area we get gastro-intestinal irritation and vomiting. The same may happen if it is taken by the mouth, and it may cause precisely the same symptoms of iodism as potassium iodide (p. 253). Iodine preparations are parasiticide to the various vegetable and animal parasites which infest the skin.

Internal.—Minute doses of the tincture occasionally stop vomiting. In the stomach iodine is converted into iodides; what is known of their action will be described presently. The vapour is very irritating to the respiratory passages. Almost all the minute amount of iodine in the body is in the thyroxin of the thyroid. Lack of intake of the necessary minute quantity of iodine leads to goitre.

Therapeutics.

External.—Iodine is rarely employed for its antiseptic properties, as chlorine is cheaper, except that it is constantly used as a paint for the skin before operations. The preparations of iodine are frequently used as counter-irritants for chronic inflammation of joints, for pleurisy, chilblains, periostitis, and many other purposes. The mild preparations of iodine are applied over chronically inflamed lymphatic glands when the cause of the swelling cannot be removed. A decolorized tincture of iodine is prepared, consisting of iodine dissolved in rectified spirit, and decolorized by a strong solution of ammonia. Its strength is about 1 in 40 nearly. It is a B. P. C. preparation, and has the advantage of not staining the skin, but it contains no iodine, for iodide and iodate of ammonium are formed. Therefore it is a much milder irritant than other iodine preparations. Any effect it may have is due to excess of ammonia. The weak tincture, or, if it can be borne, the strong, is often used as an antiparasitic for ringworm. Coster's paste, which is sometimes employed for this disease, consists of 120 grains (8 grms.) of iodine dissolved in 1 fl. oz. (30 mils) of light oil of wood tar. Morton's fluid, which was formerly used as an injection for spina bifida, consists of iodine 10 grains (6 decigrms.), potassium iodide 30 grains (20 decigrms.), glycerin 1 fl. oz. (30 mils).

Internal.—The vapour of iodine is occasionally inhaled for diseases of the lungs, but it probably does more harm than good. One or two minims of the weak tincture in half an ounce of water are often given, empirically, every half-hour in cases of vomiting, and sometimes with benefit. Preparations of seaweed have among uneducated persons a reputation for reducing obesity. If they do it is probably because the iodine, chlorine, and bromine in them set up

such dyspepsia that the proper digestion and absorption of food are prevented. Extracts of *Fucus vesiculosus*, the bladderwrack or seawrack, have been used, and are the basis of some quack preparations.

Iodipin.—(Not official.) *Synonym.*—Jodipin, Iodinol.

Dose (of 25 per cent. preparation), **30 to 60 m. (2 to 4 mils)** by mouth, subcutaneously or intramuscularly.

A compound of iodine and sesame oil prepared by repeatedly iodizing the oil by iodine monochloride. It is a thick yellow oil similar to bromipin (*see* p. 261), and the strength usually sold contains 25 per cent. of iodine. It is used for tertiary syphilis as is potassium iodide (*q.v.*). The above mentioned doses may often be greatly exceeded with advantage. Iodipin may be given by inunction, or if by the mouth, as an emulsion. The advantage of it is that iodine is given off slowly from it.

1. Potassii Iodidum.—Potassium Iodide. KI.

Source.—Dissolve iodine in liquor potassæ. Evaporate and heat the residue with charcoal; the oxygen of the iodate is carried off as carbonic oxide. Dissolve in boiling water, filter, wash, and crystallize.

Characters.—Whitish opaque cubical crystals having a saline taste, without odour if pure. *Solubility.*—4 in 3 of water; 1 in 12 of alcohol (90 per cent.); 1 in 3 of glycerin.

Incompatibles.—Bismuth subnitrate, sweet spirits of nitre, liquorice, preparations containing starch.

Impurities.—Iodates.

Dose, 5 to 20 gr.—3 to 12 decigrms.—or more.

Preparations.

1. Linimentum Potassii Iodidi cum Sapone. Potassium iodide, 30; curd soap, 40; glycerin, 20; oil of lemon, 2; water, 200.

2. Unguentum Potassii Iodidi.—Potassium iodide, 10; potassium carbonate, 0·6; water, 9·4; benzoated lard, 80.

In India, benzoated suet should be used instead of benzoated lard.

Potassium iodide is contained as a solvent in all pharmacopœial preparations of iodine.

2. Sodii Iodidum.—Sodium Iodide. NaI.

Source.—Made from a solution of soda, as potassium iodide is made from a solution of potash.

CHARACTERS.—A white, deliquescent, crystalline powder, with a saline taste. Freely soluble in water, glycerin, and alcohol.

Dose, 5 to 20 gr.—3 to 12 decigrms.

3. Acidum Hydriodicum Dilutum.—Diluted Hydriodic Acid. It is an aqueous liquid containing, when fresh, 10 per cent. by weight of hydrogen iodide, HI, and 1 of hydrogen hypophosphite, HPH_2O_2.

SOURCE.—Obtained by the action of hydrogen sulphide on a solution of iodine with the subsequent addition of hydrogen hypophosphite.

CHARACTERS.—A clear, colourless liquid.

INCOMPATIBLES.—Alkalies and their carbonates, metallic oxides, salts of silver and lead.

Dose, 5 to 10 ♏—3 to 6 decimils.

Preparation.

Syrupus Acidi Hydriodici.—Diluted hydriodic acid, 10; distilled water, 5; syrup to produce 100.
Dose, ½ to 1 fl. dr.—2 to 4 mils.

ACTION OF IODIDES.

External.—They have none. They do not irritate, and they are absorbed by the unbroken skin in very small quantities.

Internal.—There is much uncertainty about the action of iodides, and several views have been put forward. The best known is that of Binz, who teaches that they are decomposed in the body by small quantities of nascent oxygen (set free by living protoplasm) acting upon an iodide which is in an acidulated solution, the acid being provided by carbonic acid. Thus

$$KI+H_2O+CO_2=KHCO_3+HI$$

and then

$$2HI+O=H_2O+I_2.$$

We have just shown that iodine acts as an absorbent and that it leads to leucocytosis; and that iodides act in virtue of the iodine set free from them in the body is supported by the fact that the older physicians produced the same therapeutic effects by giving iodine

internally as we procure with iodides, and that iodine taken internally will produce symptoms of iodism. Potassium iodide replaced iodine in therapeutics because it does not cause the same gastro-intestinal irritation. The beneficial effects of iodides are very marked in syphilis, for although they do not kill the spirochaetes they absorb the inflammatory matter around them. Iodides are useful for goitre. They have a specific effect on the mammary gland, for they lessen the secretion of milk. In long-continued large doses they cause atrophy of the testicles and breasts. Some believe that they aid the elimination of lead, and this may be due to the fact that albuminate of lead is soluble in solutions of potassium iodide. Occasionally a well-marked feeling of general depression is produced by large doses of potassium iodide. It has recently been conclusively shown that neither iodide of potassium nor that of sodium produces any effect on the heart or blood-vessels. Iodine is rapidly eliminated by the urine, saliva, sweat, and mucous membranes. When taken in excess iodides produce a number of symptoms known as Iodism.

Iodism.—The patient complains of heavy pain over the frontal sinus, running at the nose, sore throat, increased secretion of saliva, and an eruption on the skin, consisting of patches of erythema. In rare cases there is albuminuria. The inflammation about the fauces may spread to the gums or down the trachea, setting up laryngitis, tracheitis, and bronchitis. These symptoms have been ascribed to an excessive formation of free iodine formed as mentioned above—and this is supported by the fact that they can be checked by large doses of sodium bicarbonate, which keep the fluids of the body alkaline and thus prevent the formation of free iodine—and also to the decomposition of iodides by nitrites, for minute traces of these are believed to exist in saliva, nasal and bronchial mucus, and sweat, and they will liberate

free iodine from potassium iodide. It is stated in support of this view that sulphanilic acid (dose, 60 to 90 gr., 4 to 6 mils), which forms a very stable compound with nitrous acid, will prevent iodism. The susceptibility of people to poisoning by iodides varies very much.

Therapeutics of Iodides.

The most important use of iodides is for syphilis; their value for the primary and secondary stages is comparatively slight, but they are invaluable for the tertiary stages, as they often cause the rapid absorption of nodes, gummata, and other syphilitic deposits. The pharmacopœial dose may often be exceeded: patients sometimes take two, three, or even four drachms a day. Large doses are especially used in syphilis of the nervous system. Potassium iodide is often prescribed with perchloride of mercury. The biniodide is formed and dissolved in the excess of potassium iodide. The iodine leads to the absorption of the inflammatory matter around the spirochaetes which are then killed by the mercury.

Chronic rheumatoid arthritis is often treated, and sometimes with benefit, by small doses of potassium iodide continued for a long while, but probably iodide of iron is more useful. Gonorrhœal rheumatism is often treated with potassium iodide. It frequently aids the absorption of chronic inflammatory products, even when they are not syphilitic. Therefore certain forms of joint disease, of pleurisy, and of pulmonary consolidation sometimes yield to treatment by this drug. It has been applied successfully by means of cataphoresis to parts affected with chronic rheumatism. It often benefits some forms of goitre and increases the amount of iodine in the thyroid. The attempt has been made to cure aneurysms which are inaccessible to surgery by giving potassium iodide for long periods, for it is thought that it aids the coagulation of blood in them; but as at the

same time the patient is always kept in bed, it is difficult to say how much of any improvement that may happen to take place is due to the iodide. Frequently it relieves the pain of aneurysm or angina pectoris. It is a valuable expectorant, and sometimes cures cases of bronchitis when other remedies have failed. Chronic Bright's disease has been treated with this drug. Lardaceous disease of the kidneys and other organs is benefited by it. It is recommended for asthma, and in some cases does much good, either given by the mouth, or as one of the numerous proprietary liquid inhalations sold for asthma, many of which contain iodide of potassium, acetone, and glycerin. It is occasionally given to decrease the secretion of milk. Potassium iodide perhaps causes a slightly increased excretion of both lead and mercury if they exist in the body, and it is therefore occasionally given in cases of chronic poisoning by these metals.

Sodium iodide is not so much used, but it produces the same effects as the potassium salt. Ammonium iodide (dose, 3 to 20 gr.) may be given if the potassium salt causes depression, and it is said that rubidium iodide (dose, 5 to 20 gr.) is sometimes better tolerated than potassium iodide.

Diluted hydriodic is usually given when alkaline iodides disagree and in the form of Syrupus Acidi Hydriodici. This is an excellent preparation for children.

BROMUM.

Bromine. Symbol, Br. Atomic weight, 79·92. (Not official.)

SOURCE.—Obtained from sea water and saline springs.

CHARACTERS.—A darkish brown volatile liquid with a strong and disagreeable odour. *Solubility.*—1 in 30 of water.

IMPURITY.—Iodine and chlorine.

ACTION.

Like that of chlorine and iodine. It is rarely used in medicine.

1. Potassii Bromidum.—*Potassium* Bromide. KBr.

SOURCE.—Obtained by the interaction of ferrous bromide with potassium carbonate.

CHARACTERS.—Colourless cubic crystals, readily soluble in water, with a saline taste.

INCOMPATIBLES.—Acids, acid salts, metallic salts, and strychnine.

Dose, 5 to 30 gr.—3 to 20 decigrms.

2. Sodii Bromidum.—Sodium Bromide. NaBr.

SOURCE.—Obtained in the same way as potassium bromide, sodium carbonate being used in place of potassium carbonate.

CHARACTERS.—A granular white powder in small cubic crystals with a saline taste. *Solubility.*—1 in about 2 of water.

INCOMPATIBLES.—Those of potassium bromide.

Dose, 5 to 30 gr.—3 to 20 decigrms.

3. Ammonii Bromidum.—Ammonium Bromide. NH_4Br.

SOURCE.—Made by neutralizing hydrobromic acid with liquor ammoniæ and crystallizing.

CHARACTERS.—Small colourless cubic crystals with a pungent saline taste. *Solubility.*—1 in $1\frac{1}{3}$ of water.

INCOMPATIBLES.—Acids, acid salts, strychnine, and spirit of nitrous ether.

IMPURITIES.—Iodides, free bromine.

Dose, 5 to 30 gr.—3 to 20 decigrms.

4. Strontii Bromidum.—Strontium Bromide. $SrBr_2,6H_2O$.

SOURCE. — Neutralize dilute hydrobromic acid with strontium carbonate.

CHARACTERS.—White acicular, deliquescent crystals. Soluble in less than 1 part of water and in alcohol.

Dose.—5 to 30 gr.—3 to 20 decigrms.

ACTION OF BROMIDES.

External.—They have none.

Internal.—*Alimentary canal.*—Solutions of any of these three bromides, frequently painted on the throat, diminish its sensibility. Medicinal doses have no other effect on the alimentary canal. All bromides are quickly converted into sodium bromide in the stomach and intestines, and they are readily absorbed.

Nervous system.—Bromides are powerful depressants to the nervous system. Thus, if an animal be given large doses of any of them, irritation of the cortical motor areas, which before easily excited movements, fails to do so. The reflex excitability of the cord is considerably diminished. In man at least, not only the cortical motor area but the brain as a whole is depressed; therefore these drugs are powerful hypnotics. The activity of the muscles is also diminished, not only by the action of the drugs on the nervous system, but by their direct action on them. It has been definitely shown that excessive doses of bromide of potassium cause in both man and rabbits degeneration of the cortical cells, and that this degeneration begins at the periphery of the dendrons. Bromine replaces the chlorine naturally present in the body; this appears to be unimportant except in the brain and cord, where it causes depression. Only those bromides which set free bromine in the body have this effect. The sensory side of the nervous system is unaffected, hence bromides do not relieve pain.

Circulation.—Many sufferers from epilepsy take large doses of bromides daily for years without any effect on the heart or circulation, hence the common statement that bromides in such doses are depressant is incorrect. Toxic doses produce a fall of temperature; this is probably in some way secondary to the depression of the circulation.

Respiration is slightly depressed by bromides.

Metabolism.—The amount of carbonic acid exhaled is decreased by large doses of bromides. The amount of urine is increased; the colouring matters, the sulphur, and the nitrogen in it are increased; but the phosphorus is decreased.

Sexual organs.—If bromides are taken for a long time, a failure of sexual vigour is produced, and

ultimately there is a great lessening of the sexual appetite. Bromides are therefore anaphrodisiacs.

Elimination.—Bromides are rapidly eliminated by the kidneys, skin, saliva, intestinal mucous membrane, bronchial mucous membrane, and milk.

Bromism.—If bromides are taken for too long a period, a series of symptoms of poisoning, to which the above name has been given, may appear. The earliest of them is a rash, consisting of red papules, chiefly on the face and back, exactly resembling some forms of acne. This is probably the result of the excretion of the bromide by the skin. The next symptoms are a general lowering of the cutaneous sensibility and also of that of the pharynx, then there is diminution of sexual power, the patient becomes low-spirited, easily fatigued, unfit for work, and his intellect is dulled, and in bad cases this passes on to dementia, melancholia, and other mental disorders. There may be a little conjunctivitis, and some increased secretion from the bronchi.

Bromides owe their action to the bromine in them. In man at least, the higher functions of the brain are depressed before the lower, and these again before the spinal. Thus the depression takes place in regular order from above downwards, in the reverse order of the physiological development of the functions, and this is commonly the case with many drugs. (*See* Law of Dissolution, p. 108.)

Those who take bromides habitually find themselves unable to sleep without them, and their intellect becomes obscured. These bad effects are intensified by the fact that gradually larger doses are required to produce sleep, and thus the unfortunate sufferer becomes more and more a slave to the drug.

Therapeutics of Bromides.

External.—None.

Internal.—*Alimentary canal.*—Formerly the back of the throat was painted with a solution of a bromide before a laryngeal examination, but now cocaine is employed for this purpose.

Nervous system.—Because of their depressing effect bromides are largely used for many nervous diseases. They are the most valuable drugs we have for the treatment of epilepsy, acting no doubt by diminishing the excitability of the cerebral cortex. They rarely cure, but often greatly diminish the number of fits. It is impossible to say of any given case whether bromides will do good, therefore they must be tried in all; petit mal is more difficult to influence than grand mal. The next most common use of bromides is as hypnotics. They are most useful when there is no organic cause to explain the insomnia, and therefore they are not employed when pain keeps the patient awake, but are given with great benefit in the insomnia of overwork, worry or that connected with the climacteric period. The sleep induced is quiet and refreshing, without dreams, and therefore these drugs are often of great value in nightmare, and in the night screaming of children, which may be regarded as allied to nightmare. Also because of their depressant effect on the nervous system they are given in migraine, and often they are the only drugs which do any good for the intense headache of this disease. Large doses, often a drachm at a time, are given in delirium tremens, especially in combination with chloral, and sometimes the patient seems quieter for this treatment. Not only the insomnia, but the other nervous symptoms that are common at the climacteric period may be relieved by bromides. For their depressing power on centres below the cortex they are used, and

with good results, in laryngismus stridulus, and have been given in whooping-cough, but the benefit is not marked. Some cases of tetanus have recovered after enormous doses of bromides. Here their value is, no doubt, due to their power of diminishing the reflex function of the spinal cord. Bromides have been given as antidotes for strychnine poisoning. Sometimes they succeed in cases of hysteria and neuralgia, and some varieties of functional disease of the heart are much improved by them.

Sexual functions.—Because of its depressant effect bromide of potassium is given for spermatorrhœa and nymphomania.

The bromides of potassium, sodium, ammonium, rubidium and strontium have, in the main, the same action, but potassium bromide is usually preferred; the others may be tried if the potassium salt produces cardiac depression. Monobromated camphor (one hydrogen atom of camphor is replaced by bromine) is often efficacious (dose, 2 to 10 gr., 12 to 60 centigrms., in a capsule).

The Liquor Bromidi Compositus (B. P. C.), dose, $\frac{1}{2}$ to 2 fl. dr. (2 to 8 mils)—one fl. dr. contains 15 gr. each of chloral hydrate and bromide of potassium, and, in addition, Indian hemp, hyoscyamus, orange peel, and glycerin—is an imitation of the mixture called Bromidia. Sedobrol tablets 15 gr. (1·1 grms.) of bromide in each with extractives of vegetable proteins, dissolved in a cup of hot water, form a pleasant way of giving bromide at night.

5. Acidum Hydrobromicum Dilutum.—Diluted Hydrobromic Acid.

SOURCE.—It is prepared by the interaction of potassium bromide with sulphurous acid.

CHARACTERS.—A colourless acid liquid. Sp. gr. 1·077. Contains 10 per cent. of hydrogen bromide, HBr.

Dose 15 to 60 m.—1 to 4 mils.

Action and Therapeutics.

The action of this acid appears to be the same as that of the bromides of the alkaline metals, but it is very rarely used for the same purposes. It has been employed with occasional success to relieve noises in the ears, and it is said to prevent the symptoms of poisoning by quinine.

Brominol.—*Synonym.*—Bromipin. (Not official.)

This combination of bromine with sesame oil contains 10 per cent. of bromine. The usual dose is 1 to 4 drachms (4 to 16 mils), and it may be given in an emulsion or in capsules. It is very popular with some prescribers and is used for the same conditions as other bromides, *e.g.*, epilepsy, sleeplessness, and many functional nervous disorders. A 33 per cent. strength is prepared for rectal injection.

GROUP X.

Containing **Sulphur** only.

SULPHUR.

Symbol, S. Atomic weight, 32·07.

Sulphur is official in two forms.

1. Sulphur Sublimatum.—Sublimed Sulphur. *Synonym.*—Flowers of sulphur.

Source.—From crude sulphur or sulphides by sublimation.

Characters.—A greenish-yellow gritty powder.

Impurities.—Sulphurous and sulphuric acids, sulphide of arsenic, earthy matters.

Dose, 20 to 60 gr.—12 to 40 decigrms.

Preparation.

Unguentum Sulphuris.—Sublimed sulphur, 1; benzoated lard, 9.

In India benzoated suet should be employed instead of benzoated lard.

Sublimed sulphur is contained in Pulvis Glycyrrhizæ Compositus.

2. Sulphur Præcipitatum.—Precipitated Sulphur. *Synonym.*—Milk of sulphur.

Source.—Sulphur is precipitated by hydrochloric acid from a solution of calcium sulphides and thiosulphate, which has been made by boiling together sulphur and lime in water.

Characters.—A greyish-yellow soft powder free from grittiness.

Impurity.—Calcium sulphate, which makes it gritty.

Dose, 20 to 60 gr.—12 to 40 decigrms.

Preparations.

1. **Confectio Sulphuris.**—Precipitated sulphur, 450; acid potassium tartrate, 110; tragacanth, 5; syrup, 210; tincture of orange, 55; glycerin, 170.

   Dose, 60 to 120 gr.—4 to 8 grms.

2. **Trochiscus Sulphuris.** — Precipitated sulphur, 150; potassium acid tartrate, 30; sugar, 275; gum acacia, 30; tincture of orange, 30; mucilage of gum acacia, 30. Each lozenge contains 0·3 grm. or 5 gr. of sulphur and 0·06 grm. or 1 gr. of potassium acid tartrate.

Action of Sulphur.

External.—Sulphur itself has no action on the skin, but some of it is converted into sulphuretted hydrogen, and that is a mild vascular stimulant causing slight dilatation of the vessels and in some persons eczema. It kills the *Sarcoptes hominis*, and is therefore a **parasiticide.** When applied to raw surfaces it is converted into sulphurous and sulphuric acids, and is therefore a severe irritant.

Internal.—*Alimentary canal.*—It has no effect on the stomach, and most that is taken is passed out in the fæces unaltered. A certain amount is, in the intestine, converted into sulphuretted hydrogen and other sulphides. These cause a **mild laxative** effect, increasing the secretion of intestinal juice, and slightly stimulating the muscular coat, producing soft semi-liquid stools, sometimes accompanied by flatus of sulphuretted hydrogen, which, if in sufficient quantity, makes sulphur an undesirable laxative.

Remote effects.—Sulphur is absorbed as sulphides and sulphuretted hydrogen, which is a powerful poison, decomposing the blood and thus producing symptoms of asphyxia. It also paralyses the whole nervous and muscular systems, but sulphur is never given to man in sufficient doses to produce any remote effects. Patients taking sulphur get rid of some minute portion of it as sulphuretted hydrogen through the kidneys, the milk, the lungs, and skin, and some as sulphates in the urine. The breath occasionally smells of it, and silver ornaments next to the skin may be discoloured.

Therapeutics of Sulphur.

External.—Sulphur is commonly used to kill the *Sarcoptes hominis*, and thus to cure scabies. The skin should be well scrubbed with soft soap and hot water to lay open the burrows. Then it is thoroughly rubbed with the ointment. The patient should do this before bedtime, sleep in flannel, and wash the ointment off the next morning. This proceeding repeated three or four times will generally cure the disease. Sulphur ointment was formerly applied as a stimulant to ulcers, and was rubbed in for chronic rheumatism, but these modes of treatment are now rarely used, and their value is doubtful. Mild sulphur preparations are applied for acne.

Internal.—*Alimentary canal.*—Sulphur is a very good laxative, especially for children; as it produces a soft motion but no pain, it is useful for cases of piles or fissure of the anus. Sublimed sulphur is contained in compound liquorice powder, which is an excellent and popular laxative. One or two sulphur lozenges taken at bedtime often secure an easy evacuation of the bowels the next morning in persons liable to slight constipation. These lozenges have been recommended for constipation associated with

hepatic disease, and many mineral waters containing sulphides of sodium and hydrogen have considerable reputation for hepatic disorders. Of these, Harrogate water claims to increase the amount of bile and the solids in it.

Remote effects.—Sulphur has been administered internally for all sorts of skin diseases, generally without any good result, but occasionally chronic eczema associated with much itching appears to be benefited by it, so that the sulphur lozenge is a suitable laxative for these cases. Sulphur has been also given for bronchitis, for chronic rheumatism, and rheumatic myalgia, but it is very doubtful whether in these diseases there is much relief from this treatment.

Potassa Sulphurata.—Sulphurated Potash. *Synonym.*—Liver of sulphur. A mixture of salts of which the chief are potassium sulphides.

Source.—Heat in a crucible a mixture of sulphur and potassium carbonate.

Characters.—Dull green solid masses, the freshly broken surfaces of which are liver-coloured.

Calx Sulphurata.—Sulphurated Lime. A mixture containing not less than 50 per cent. of calcium sulphide with calcium sulphate and carbon.

Source.—Heat calcium sulphate with wood charcoal.

Characters.—A greyish-white powder, smelling of sulphuretted hydrogen.

Dose, ¼ to 1 gr.—16 to 60 milligrms.

Action of Sulphurated Potash and Sulphurated Lime.

External.—These preparations are irritant, and are powerful parasiticides for the *Sarcoptes hominis*.

Internal.—Nothing is known of their internal action.

Therapeutics of Sulphurated Potash and Sulphurated Lime.

External.—An ointment of either will cure scabies, and a sulphurated potash ointment (1 in 80) is often used for this purpose in the same way as sulphur ointment. Both drugs have been used for many chronic skin diseases, but now they are not often employed. They appear, however, occasionally to do good to cases of acne indurata. Baths containing sulphides in solution are considered by many to be very useful for chronic rheumatic arthritis and rheumatic myalgia. The famous natural sulphide baths are those of Aix-la-Chapelle, Aix-les-Bains, and there are many others, which will be found described in works on general therapeutics; but as in all of them the water is warm, and warm water is beneficial for chronic rheumatism, and the sulphides exist in infinitesimally small quantities, it is very probable that the benefit is due more to the heat of the water than to its constituents. An artificial bath (sulphurated potash 4 oz., water 30 gals.) is used for chronic psoriasis.

Internal.—Sulphides have been given for chronic rheumatism, various skin diseases, and phthisis, but the evidence of the good done is scanty. Calx Sulphurata has been especially recommended for boils, carbuncles, and tubercular glands in the neck. Half a grain or a grain should be given every four hours. It is best made into a pill with acacia, milk sugar, and syrup.

GROUP XI.

ACIDS.

Those acids which will be considered here may be divided into two classes.

Class I. Those which are strongly acid, the more powerfully acid being active caustics. They are **Sulphuric, Nitric, Hydrochloric, Nitro-hydrochloric, Phosphoric, Acetic, Tartaric, Citric, Lactic,** and **Formic** acids. **Hydrobromic** acid and **Hydriodic** acid might be placed here, but they have already been considered.

Class II.—Those which, although feebly acid, are antiseptic. They are **Sulphurous** and **Boric** acids.

Dilute hydrocyanic, carbolic, benzoic, oleic, tannic, and salicylic acids are not used as acids, and will be considered under other headings.

Arsenious acid and chromic acid are not true acids; they are anhydrides, and have already been considered (*see* pp. 225 and 240). Oxalic acid is in the Appendix to the Pharmacopœia as a test.

Class I.

1. Acidum Sulphuricum. — Sulphuric Acid contains not less than 95 per cent. of hydrogen sulphate, H_2SO_4.

Source.—Produced by the combustion of sulphur or pyrites, and the oxidation and hydration of the resulting sulphur dioxide by means of nitrous and aqueous vapours.

Characters.—A colourless liquid, of an oily consistency, intensely acid and corrosive. Sp. gr. 1·841.

Impurities.—Oxides of nitrogen, lead, arsenic.

Incompatibles.—Alkalies, their carbonates, lead, and calcium salts.

Preparations.

1. Acidum Sulphuricum Dilutum.—Sulphuric acid, 112·5; distilled water, 940; sp. gr. 1·069. Contains 10 per cent. of hydrogen sulphate, H_2SO_4.

Dose, 5 to 20 m.—3 to 12 decimils.

It is contained in Infusum Rosæ Acidum.

2. Acidum Sulphuricum Aromaticum.—*Synonym.*—Elixir of vitriol. Sulphuric acid, 70; spirit of cinnamon, 15; tincture of ginger, 250;

alcohol (90 per cent.), to produce 1000. Sp. gr. 0·917 to 0·923. It contains much ethyl sulphuric (sulphovinic) acid.

Dose, 5 to 20 m.—3 to 12 decimils.
It is contained in Infusum Cinchonæ Acidum.

2. Acidum Nitricum.—Nitric Acid contains 70 per cent. of hydrogen nitrate, HNO_3, and 30 per cent. of water.

Source.—Made from sodium nitrate by distilling with sulphuric acid.

Characters.—A colourless, fuming, very acid liquid. Sp. gr. 1·42.

Impurities.—Sulphuric acid, nitre, and lower oxides of nitrogen, giving ruddy fumes.

Incompatibles.—Alcohol, alkalies, carbonates, oxides, iron sulphate, lead acetate.

Preparations.

1. Acidum Nitricum Dilutum.—Nitric acid, 151; distilled water to produce 1000. Contains 10 per cent. of hydrogen nitrate, HNO_3.

This preparation is approximately three-fifths the strength of the corresponding preparation, B.P. 1898.

Dose, 5 to 20 m.—3 to 12 decimils.

2. Acidum Nitro-hydrochloricum Dilutum.—Nitric acid, 3; hydrochloric acid, 4; distilled water, 25. Make fourteen days before use. Contains free chlorine, hydrochloric, nitrous, and nitric acids dissolved in water. The fumes given off consist of nitrosyl chloride. Sp. gr. 1·07.

Dose, 5 to 20 m.—3 to 12 decimils.

3. Acidum Hydrochloricum.—Hydrochloric Acid.

Source.—The fumes produced by the action of sulphuric acid on sodium chloride are dissolved in water.

Characters.—A colourless, very acid, fuming liquid. Sp. gr. 1·16. Contains 31·79 per cent. of hydrogen chloride, HCl, and 68·21 per cent. of water.

Incompatibles.—Lead and silver salts, alkalies and their carbonates.

Preparations.

1. **Acidum Hydrochloricum Dilutum.**—Hydrochloric acid, 33; distilled water to produce 100.

Dose, 5 to 20 m.—3 to 12 decimils.

2. **Acidum Nitro-hydrochloricum Dilutum,** *see* Nitric Acid.

4. Acidum Phosphoricum Concentratum.—Concentrated Phosphoric Acid is a liquid containing 66·3 per cent. of hydrogen orthophosphate, H_3PO_4 and 33·7 per cent. of water.

Source.—Obtained by the oxidation of phosphorus.

Characters.—A colourless syrupy liquid, of a sour taste. Sp. gr. 1·5.

Incompatibles.—Calcium preparations, sodium carbonate.

Preparation.

Acidum Phosphoricum Dilutum.—Concentrated phosphoric acid, 159·5; water to produce 1000. It contains 10 per cent. of hydrogen orthophosphate.

Dose, 5 to 20 m.—3 to 12 decimils.

5. Acidum Aceticum.—Acetic Acid.

Source.—Obtained from wood by destructive distillation and purification, or from ethylic alcohol by oxidation.

Characters.—A colourless liquid. Sp. gr. 1·044. Contains 33 per cent. of hydrogen acetate, $HC_2H_3O_2$ and 67 of water.

Impurities.—Lead and copper, sulphuric, hydrochloric, and sulphurous acids.

Preparations.

1. **Acidum Aceticum Dilutum.**—Acetic acid diluted with distilled water until it has a sp. gr. 1·007, and contains 5 per cent. of hydrogen acetate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

2. **Oxymel.**—Acetic acid, 1; water, 1; purified honey, 5.

Dose, ½ to 2 fl. dr.—2 to 8 mils.

6. Acidum Aceticum Glaciale. — Glacial Acetic Acid.

Characters.—A colourless very acid liquid. Sp. gr. 1·058. Contains not less than 98·9 per cent. of hydrogen acetate, $HC_2H_3O_2$.

7. Acidum Citricum.—Citric Acid, Hydrogen Citrate.

SOURCE.—Obtained from the juice of the fruits of various species of Citrus, and contains not less than 99·5 per cent. of hydrogen citrate, $H_3C_6H_5O_7,H_2O$.

CHARACTERS.—Large colourless trimetric prisms, very soluble in water. **35 gr. to 1 fl. oz.** of water make a solution the **same average strength as lemon juice,** and **neutralize 50 gr. of potassium bicarbonate, 42 gr. of sodium bicarbonate, or 26 gr. of ammonium carbonate.** Citric acid, like tartaric acid, is often used to produce an effervescing mixture with one of the above carbonates, the two solutions being mixed immediately before taking. The carbonic acid gas which causes the effervescence is formed thus:—$3KHCO_3 + H_3C_6H_5O_7 = K_3C_6H_5O_7 + 3CO_2 + 3H_2O$.

INCOMPATIBLES.—Potassium tartrate, alkaline carbonates, acetates.

IMPURITIES.—Copper, lead, sulphuric and tartaric acids, mineral matters.

Free citric acid is contained in Succus Limonis, Syrupus Limonis.

Dose, 5 to 20 gr.—3 to 12 decigrms.

8. Acidum Tartaricum.—Tartaric Acid, or dextro-rotatory hydrogen tartrate. It contains not less than 99 per cent. of hydrogen tartrate, $H_2C_4H_4O_6$.

SOURCE.—Prepared from potassium acid tartrate.

CHARACTERS.—Colourless opaque monoclinic prisms, longer than those of citric acid. Very soluble in water. **35 gr. neutralize 46 gr. of potassium bicarbonate, 38 gr. of sodium bicarbonate, or 24½ gr. of ammonium carbonate.**

INCOMPATIBLES.—Salts of potassium, calcium, mercury, lead, vegetable astringents.

IMPURITIES.—Lead, oxalic acid, lime, and potassium tartrate.

Tartaric acid is contained in Pilula Quininæ Sulphatis.

Dose, 5 to 20 gr.—3 to 12 decigrms.

9. Acidum Lacticum.—Lactic acid is an aqueous solution containing not less than 75 per cent. of hydrogen lactate, $HC_3H_5O_3$, and not less than 10 per cent. of lactide, $C_6H_8O_4$.

Source.—It may be made by the fermentation of lactose.

Characters.—A colourless syrupy liquid. Sp. gr. 1·21. Mixes well with water, alcohol, and ether.

Impurities.—Mineral acids, sugar, lead, and iron.

Dose, 15 to 30 m.—1 to 2 mils.

Preparation.

Syrupus Calcii Lactophosphatis (*see* p. 163).

Action of Sulphuric, Nitric, Hydrochloric, Phosphoric, Acetic, Citric, Tartaric, and Lactic Acids.

External.—All these acids are powerful irritants when applied externally. The feeblest is citric. Its concentrated solution has no action on the sound skin, but is irritant to mucous membranes and abraded surfaces. Tartaric is stronger than citric acid; it will act upon the unabraded skin, and applied to a sore it produces pain, a sensation of burning, and considerable vascular dilatation. The remaining acids are very powerful irritants, therefore even weak dilute solutions of them may produce considerable redness and perhaps vesication, and when the solution is strong they are very energetic caustics; sulphuric and phosphoric acids, having a powerful affinity for water, are especially active. Sulphuric acid leaves the carbon untouched, therefore it blackens; nitric stains the skin a deep yellow owing to the formation of nitro-derivatives of tyrosine; it does not redissolve the albumen it precipitates, and it is consequently limited in its area of action; nitro-hydrochloric is very powerful; hydrochloric is the least active of the mineral acids; glacial acetic acid is useful when a limited action is required. All the stronger acids unite with and coagulate albumen; hence weak solutions, not strong enough to form a slough, which by its separation may cause bleeding, will, by coagulating the blood and so

plugging the vessels, and by coagulating the albumen in the tissues and so constricting the vessels, act as astringents and hæmostatics. Dilute solutions of acids are cooling to the flushed skin of fever, therefore they are called refrigerants. Acids are general protoplasmic poisons, hence they kill many micro-organisms, are antiseptic, and locally applied to the heart depress it.

Internal.—*Mouth.*—All acids have a peculiar taste, and give rise to a feeling of roughness about the teeth. With regard to the saliva they increase the amount secreted, consequently by keeping the mouth moist they allay thirst.

Stomach.—Nitric acid interferes with digestion of proteins, as it combines with them. When the amount of acid secreted by the gastric mucous membrane is deficient, acids taken after a meal, when all that the stomach can secrete has been secreted, aid digestion, hydrochloric being the best.

Pancreas.—Acids experimentally placed in, or passed from the stomach into, the duodenum convert the prosecretin existing in the duodenal mucous membrane into secretin, and, this being absorbed into the blood, excites the pancreatic flow.

Intestine.—Acids quickly become converted into neutral salts, and are probably mainly absorbed as such. Some, especially sulphuric (diluted), are believed to preserve in the intestine their astringent action. They have been said to increase the amount of bile, especially nitric and nitro-hydrochloric acids, but this is incorrect. The presence of acids in the duodenum leads to reflex closure of the pylorus; hence when sufficient of the gastric contents have passed into the duodenum, the pylorus closes, and relaxes again as the duodenal contents are neutralized and passed on. Lactic acid is believed to be an excellent intestinal disinfectant, especially of the large bowel.

Remote effects.—Acids can only increase the acidity of the blood slightly, if at all; for even if absorbed as acids they are neutralised by combining with the bases of the blood and tissues, thus displacing carbonic acid, so that the blood contains less carbonic acid. In man and the carnivora these acids are also neutralised by ammonia. They are excreted in the urine, neutralised partly by bases, partly by ammonia, so that the ammonia nitrogen ratio rises, but the acidity of the urine is only slightly increased. Phosphoric acid is believed to increase the amount of phosphates in the red blood-corpuscles. The administration of hydrochloric acid will increase the number of red corpuscles in chlorosis, but it does not alter the amount of hæmoglobin. Nitric acid is stated to be excreted to a small extent as ammonia, and hence slightly to increase the alkalinity of the urine. Acetic, citric, lactic, and tartaric acids are mainly oxidised in the body to carbonic acid. This has already been discussed (*see* p. 135). Alkaline citrates inhibit the coagulation of blood. Large doses of mineral acids increase respiration and produce a comatose condition in herbivora by increasing the acidity of the blood. In carnivora this result is very difficult to obtain owing to the neutralisation of the acid by ammonia.

THERAPEUTICS OF SULPHURIC, NITRIC, HYDROCHLORIC, PHOSPHORIC, ACETIC, CITRIC, TARTARIC, AND LACTIC ACIDS.

External.—Nitric acid is more often used as a caustic than the others, for, owing to their great affinity for water, it is difficult to limit the action of sulphuric and phosphoric acids; and the remaining acids are not so powerful as nitric acid. It is

employed to destroy warts, condylomata, unhealthy phagedænic sores, and cancrum oris. Glacial acetic acid is used for small warts and corns. If this causes pain it may be diluted. Very diluted solutions are rarely employed for their irritant effects; at some bathing establishments acid baths are used, but it is not proved that they do any good. Any well-diluted acid, especially sulphuric, may be applied to check slight bleeding, as that of leech-bites and piles. Vinegar can always be obtained; even it should be diluted. In fever the skin is often bathed with vinegar as a refrigerant, and very dilute sulphuric acid is used as a local astringent in the sweating of phthisis.

Internal.—*Mouth.*—As acids damage the teeth they should be taken through a glass tube. Lemon juice or citric acid itself is often used to stimulate the secretion of saliva, and hence allay the thirst of fever patients. Lemonade is a favourite drink for this purpose. Lactic acid has been strongly recommended to dissolve off the membrane in diphtheria, but there is no evidence that this treatment benefits the patient. Equal parts of lactic acid and water may be applied with a mop, or a spray of a strength of 1 fl. dr. to 1 fl. oz. of water may be employed. Very dilute nitric acid has been used for the same purpose. Lactic acid may be applied with a brush in tuberculosis of the larynx, and in some cases with good results. It is usual to begin with lactic acid 50 per cent., water 25 per cent., and glycerin 25 per cent. The strength of the solution is increased till at last lactic acid alone is used. Other accessible tuberculous ulcers—as those of the tongue and skin—may be treated in the same way.

Stomach and Intestines.—Hydrochloric and to a less extent nitro-hydrochloric acids are of the greatest value to that variety of dyspepsia in which the acidity of the gastric juice is deficient. They

should, as already explained, be given some little while after a meal. A very usual stomachic mixture consists of dilute nitro-hydrochloric acid combined with tincture of nux vomica and some other stomachic, as compound tincture of gentian. Lactic acid has been used for the same purpose. Acids will often alleviate that form of indigestion in which the patient complains of acid eructations and heartburn. For this purpose they should be given during a meal or before it. Possibly they then act by restraining fermentation. An acid mixture sometimes benefits the indigestion of pregnancy, and small doses of hydrochloric acid may be prescribed during typhoid and other fevers, because the secretion of this acid is much diminished when the temperature is raised. Vinegar is sometimes drunk to reduce obesity, but it only does so because a long course of any acid will set up a mild gastritis, and thus hinder the digestion and absorption of food. Carbonic acid, taken in an effervescing mixture, is a common and very efficacious gastric sedative, beneficial therefore in painful dyspepsia and in vomiting. Dilute sulphuric acid may be used as a hæmostatic in bleeding from the stomach or intestines, but its action is feeble. It is, however, successful as an astringent in many cases of summer diarrhœa. Nitric and nitro-hydrochloric acids, incorrectly reputed to increase the amount of bile, are given, and sometimes with much benefit, when it is considered that dyspepsia is due to disordered function of the liver. Dilute sulphuric acid is often taken by workers in lead factories, as it forms an insoluble sulphate of lead in the intestines, and so prevents absorption of lead.

Soured milk is occasionally of benefit in many intestinal diseases, *e.g.* summer diarrhœa and colitis. Several powders, *e.g.* lacto-bacilline, and liquids are in

the market, each said to contain a mixture of lactic acid bacilli; of these the Eastern varieties, e.g. the Bulgarian bacillus, are the most valuable. Previously sterilised milk is sown with a suitable powder or liquid and maintained in a Thermos flask at a temperature of 100°–104° F. (38°–40° C.) for from eight to twelve hours when it is curdled and not too bitter for taste. It may then be drunk like ordinary milk—two or three pints a day for an adult—and the still active lactic acid bacilli in it inhibit the growth of intestinal micro-organisms and the lactic acid formed from the lactose in the milk acts as an intestinal disinfectant. This soured milk is especially useful for diseases of the large bowel.

Remote effects.—The remote effects of salts of citric, tartaric, and acetic acids have already been described (p. 135). They are due to the increase in the alkalinity of the blood and the urine. Phosphoric acid is often given to weak, sickly, anæmic children with the view of improving the quality of the red blood-corpuscles, and possibly aiding the growth of bones, but it has not been proved to have any great value. The same may be said of the vegetable acids when employed for scurvy, and of lactic and phosphoric acids when given for diabetes; indeed, the latter are said to do harm. Lime juice was formerly a popular remedy for acute rheumatism, but it did little if any good. Sulphuric acid is by some said to be anhidrotic in the night sweating of phthisis, and had some reputation as a remote hæmostatic, but it is rarely given now for these purposes. Aromatic sulphuric acid, with a little syrup and water, forms a pleasant cooling drink in fever. Röhrig found that acids diminished the tracheal secretion, and some physicians find that they diminish the secretions in bronchitis. Alkaline citrates, diminishing the coagulability of the blood outside the body, have been given

for thrombosis, but it is probably impossible to give enough to produce any appreciable result. We thus see that the remote effects of all acids, except citric, tartaric, and acetic, are unimportant.

10. Formic Acid.—(Not official.) *Synonym.*—Aminic Acid, CH_2O_2. A colourless pungent caustic liquid.

Dose, 2 to 10 m.—12 to 60 centimils.—diluted with water. Given hypodermically **2–5 m.—12 to 30 centimils** —(1 in 1,000 solution).

This acid is believed to increase the tone of muscles and so has been given in general weakness such as that which follows influenza and for fatigue of the ocular muscles. It is usually given as sodium formate (**Dose, 10 to 45 gr., 6 to 30 decigrms.**). It may be flavoured with syrup and vanilla. Elixir Formatum (B. P. C.), **Dose, 1 to 2 fl. dr., 4 to 8 mils,** is a useful preparation. The Syrupus Glycerophosphatum cum Formatibus B. P. C. (**Dose, 1 to 2 fl. dr. 4 to 8 mils**) is a good preparation as a general tonic.

Toxicology of Acids.

All these acids are severe gastro-intestinal irritants when given in toxic doses. Tartaric, citric, and lactic are very rarely taken as poisons. The symptoms produced by the whole class are severe burning pain extending from the mouth to the stomach, excoriation of the mouth with the formation of sloughs, great difficulty in swallowing, vomiting of dark brown coffee-coloured material and shreds of mucus, intense abdominal pain aggravated by the slightest movement, generally obstinate constipation, but if the bowels are open the motions are dark, from the blood contained in them. Some of the acid generally passes down to the larynx and causes swelling of that organ, and consequently dyspnœa from obstruction to respiration. The patient becomes cold, collapsed, and covered with a cold sweat; his pulse is very feeble, and he suffers from great thirst. *Post mortem.*—The mucous membrane of the mouth and gullet is softened and corroded, and whitish-grey sloughs and hæmorrhages may be seen here and there. The coats of the stomach are softened. It is often contracted, and it may be perforated, the aperture being irregular. If the acid escapes into the peritoneal cavity, it may act on almost any of the abdominal organs. Should the patient have lived long enough, there may be corrosion

and inflammation of parts of the small intestine. The mucous membrane of the throat and larynx is inflamed and swollen.

Treatment.—Alkalies should be given at once, e.g. soap and water, lime water, magnesia, washing soda; and then demulcents, as milk, white of egg, oil, linseed tea. Do not use the stomach-tube if sulphuric acid has been taken, otherwise gently wash out the stomach. Morphine may be injected subcutaneously for the pain, and brandy subcutaneously for the collapse.

Class II.

1. Acidum Sulphurosum.—Sulphurous Acid.

Source.—An aqueous solution containing 6·4 per cent. of hydrogen sulphite H_2SO_3 corresponding to 5 per cent. by weight of sulphur dioxide, SO_2. The sulphur dioxide may be obtained by heating sulphuric acid with charcoal or sulphur.

Characters.—A colourless liquid with a sulphurous odour. Sp. gr. 1·025.

Impurities.—Sulphuric acid, mineral matters.

Dose, ½ to 1 fl. dr.—2 to 4 mils. Best given in Mistura Amygdalæ.

Action.

External.—Sulphurous acid is strongly deoxidizing, and as it takes up oxygen so easily from organic bodies, it readily decomposes them, becoming itself converted into sulphuric acid, and hence is irritant, but not violently so, for the amount of sulphuric acid in proportion to the water is slight. It is a disinfectant and deodorant, for, in virtue of its property of absorbing oxygen, it destroys micro-organisms and arrests fermentation. When applied to the skin it is a parasiticide.

Internal.—It is believed to act as a disinfectant in the stomach and intestines, but it is very doubtful whether enough of it to have any appreciable action in this direction can be safely taken.

Therapeutics.

External.—Sulphurous acid is chiefly used as an antiseptic, disinfectant, and deodorant. Sulphurous

anhydride is employed as a disinfectant for a sick room after a patient with an infectious disease has been in it. The chimneys and windows should be stopped up. A quarter to half a pound or more of flowers of sulphur is placed in an earthenware vessel and lighted. The door is shut, and the cracks around it pasted over. The room should be left untouched for six hours. Generally not enough sulphur is burnt for this method to be efficacious. Sulphurous acid (2 fl. dr. to 1 fl. oz., 8 to 30 mils, of water) is locally applied to cure ringworm. Foul sores may be washed with it.

Internal.—Sulphurous acid is sometimes given internally with the object of preventing abnormal fermentation in the stomach and intestines in certain varieties of dyspepsia, but there is no clinical proof that it can do this, and it should be remembered that it is possible it may do harm by impeding the action of the normal ferments.

2. Acidum Boricum.—Boric Acid. *Synonyms.*—Boracic acid, Hydrogen borate.

SOURCE.—Obtained by the action of sulphuric acid on borax. Contains not less than 99·5 per cent. of orthoboric acid, H_3BO_3.

CHARACTERS.—Colourless, pearly, lamellar crystals, feebly acid. *Solubility.*—1 in 25 of cold water; 1 in 3 of boiling water; 1 in 4 of glycerin; 1 in 30 of alcohol (90 per cent.). The solubility of boric acid is greatly increased by the addition of borax.

INCOMPATIBLE.—With sodium salicylate in powder a borosalicylate is formed.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Preparations.

1. Glycerinum Acidi Borici.—Boric acid, 3; glycerin, 10. This is an imitation of Boro-glyceride (*see* p. 281).

2. Unguentum Acidi Borici.—Boric acid, finely powdered, 1; white paraffin ointment, 9.

3. Borax Purificatus.—Borax, Sodium Pyroborate. *Synonym.*—Sodium biborate. $Na_2B_4O_7,10H_2O$.

Source.—Neutralize boric acid with sodium carbonate, or boil native calcium borate with a solution of sodium carbonate. Also found native.

Characters.—Transparent colourless crystals, alkaline, with a sweetish taste. *Solubility.*—1 in 25 of cold water; 1 in 1 of glycerin; not in alcohol.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Preparations.

1. Glycerinum Boracis.—Purified borax, 1; glycerin, 6. Sodium metaborate, glyceryl borate, and boric acid are formed.

2. Mel Boracis.—Purified borax, 10; glycerin, 5; purified honey, 85. A similar decomposition takes place here.

Action of Boric Acid and Borax.

External.—Both boric acid and borax destroy micro-organisms, and are thus disinfectant and antiseptic, but their value is slight, and they are much more active in preventing than in inhibiting decomposition. The effect is extremely local. Solutions of boric acid will relieve itching. Neither substance produces any irritation. Boric acid is used to preserve milk, butter, and animal food.

Internal.—Borax and boric acid check the action of saliva on starch, but, if anything, they increase the action of the gastric juice and the pancreatic secretion. Large amounts, however, slightly retard digestion, and still larger are gastro-intestinal irritants. Boric acid is rapidly eliminated in the urine; it is said to increase the urea and the quantity of urine. It is also excreted in the saliva, sweat, and fæces, and it is stated in rare cases to cause abortion. It may cause a scaly eruption. In exceptional instances, when large quantities have been applied to raw surfaces or mucous membranes, rise of temperature, depression of spirits, feeble pulse, ecchymoses, lumbar pain,

albuminuria, and nausea, vomiting, and diarrhœa have supervened. Harmful symptoms do not follow from taking food preserved with boric acid if the amount of it is small, such as anything under 0·1 per cent. in milk, or 8 grains to the pint, but they may follow if large amounts are used; but its employment is undesirable, as the prolonged use of food preserved with boric acid may lessen the weight of the body. It should never be used for solid foods. It has been shown that borax and boric acid given in daily moderate doses to children do not obviously adversely affect metabolism, nor do they restrain intestinal putrefaction, but larger doses diminish nitrogenous metabolism.

Therapeutics of Boric Acid and Borax.

As they do not irritate, both these substances are largely used to keep wounds, ulcers, and sores sweet. The action is so local that they cannot be used to dress cavities. Boracic lint is much employed to dress wounds. It is made by passing lint through a hot saturated solution of boric acid. Boracic cotton wool is made the same way; both are tinted pink. Lister's boric acid ointment consists of boric acid 1 part, white wax 1 part, paraffin 2 parts, almond oil 2 parts. A saturated solution of boric acid (4 per cent.), or a watery solution of 1 in 40 of the patented preparation boro-glyceride (*see* p. 281), may be employed as an antiseptic wash. Such solutions are used for ozæna, vaginitis, urethritis, fetid perspiration of the feet, and ophthalmia. Colitis is occasionally benefited by washing out the large bowel with a couple of pints of a saturated solution of boric acid; sometimes tannic acid is added. Lister's ointment, or an ointment of boro-glyceride, may be used for pruritus, sunburn, &c. Powdered boric acid blown into the ear is very useful in fetid discharges from it. Thompson's

fluid (borax, 1 oz., 32 grms.; glycerin, 2 fl. oz., 60 mils; water, 2 fl. oz., 60 mils), in the proportion of ½ fl. oz., 15 mils, to 4 fl. oz., 120 mils, of warm water, is commonly employed to wash out the bladder in cystitis. The glycerin and the honey of borax are used for aphthous states of the mouth, especially in children. The following is a popular wash for the mouth:—Glycerin of borax, 1 fl. dr., 4 mils; tincture of myrrh, 10 ♏, 6 decimils; water to 1 fl. oz., 30 mils; but it must be remembered that glycerin hinders the antiseptic power of the borax. Listerine, used as a lotion or mouth wash, contains many ingredients, of which the chief is boric acid.

Borax has been given in epilepsy, and its use is gaining ground. It is often prescribed with advantage in combination with bromides, but it is decidedly inferior to them, although in exceptional cases it may succeed when they have failed. As it is an antiseptic it has been given internally in typhoid fever and phthisis, but with doubtful benefit. Taken internally it is said to relieve irritability of the bladder. In rare cases its use has caused either psoriasis, a papular eruption especially marked near the elbows, an erythematous rash, or eczema. Nausea, loss of appetite, vomiting, and diarrhœa may be produced. It has no effect on the intelligence. The taste is best covered with syrup of orange peel. Boric acid given internally is a useful urinary antiseptic, especially if the urine is alkaline.

Boro-glyceride.—(Not official.)

Source.—Heat 92 parts of glycerin with 62 of boric acid.

Characters.—A tough deliquescent mass, readily soluble in water and alcohol.

It is a powerful antiseptic, and has been used as a dressing for wounds (*see* p. 280). The pharmacopœial imitation of it is Glycerinum Acidi Borici (*see* p. 278).

GROUP XII.

CARBON AND ITS COMPOUNDS.

Class I.—Carbon.

CARBO.

Carbon. Symbol, C. Atomic weight, 12.

Carbon is only official as

Carbo Ligni.—Wood Charcoal.

Source.—Wood charred by exposure to red heat without access of air.

Characters.—A black powder without odour or taste.

Action.

External.—Dry charcoal absorbs gases and condenses them within its pores. It thus absorbs oxygen, and hence has an oxidizing power, parting with the absorbed oxygen to oxidize organic and other substances. Organic matter is believed to be decomposed by aerobic micro-organisms which act by oxidation, and anaerobic which decompose directly, producing offensively smelling and toxic bodies. Wild suggests that the reason for the deodorant action of charcoal is that it converts anaerobic into aerobic decomposition. It attracts and oxidizes colouring matters, and consequently decolorizes them. It has no effect on living organisms, and is not antiseptic.

Internal.—Formerly it was thought only to oxidize when dry, but to a less degree it has this power when moist, presumably because there is still some active oxygen in its interstices. It is passed in the fæces unchanged.

THERAPEUTICS.

External.—Charcoal has been recommended as a deodorant for foul ulcers, but it is a dirty preparation, and large quantities must be used. Charcoal is used in pharmacy as a decolorizing agent.

Internal.—It has been given as a powder, as lozenges, and as biscuits, with the object of preventing fermentation in the stomach, but it is not of much use. Garrod has shown that a tablespoonful or larger doses of charcoal frequently repeated are antidotes against most active vegetable poisons, as opium, nux vomica, and aconite, for charcoal seems to have a special attraction for alkaloids. Animal charcoal is the best form to give as an antidote. Charcoal is used as a tooth powder.

CLASS II.—**Ethylic Alcohol, Chloroform, Bromoform, Ether, Acetic Ether, Acetone, Æthyl Chloride, Methyl Chloride, and Æthyl Bromide.**

All these substances produce local anæsthesia by evaporation. They are rubefacient if their vapour is confined. The stomach, heart, and central nervous system are first stimulated and then depressed by them. Nitrous oxide is considered with them for convenience.

ALCOHOL ETHYLICUM.

Ethylic Alcohol. Ethyl hydroxide. C_2H_5OH.
Ethyl hydroxide is official in the eight following forms:

1. Alcohol Absolutum. Absolute alcohol (strictly this is an incorrect name, for it may contain 1 per cent. by weight of water). Often called "alcohol."

SOURCE.—Obtained by the dehydration of less strong ethylic alcohol and subsequent distillation.

CHARACTERS.—A colourless, very volatile and hygroscopic fluid free from odour. Sp. gr. 0·794 to 0·7969. Contains not less than **99** per cent. *by weight* of alcohol, and not more than **1** per cent. water.

2. Spiritus Rectificatus.—Rectified Spirit. **Ethyl Hydroxide, 90** per cent. *by volume*; **Water, 10** per cent.

Source.—Obtained by distillation of fermented saccharine liquids.

Characters and Tests.—Colourless, transparent, inflammable liquid with a burning taste. Sp. gr. 0·8337. No residue when evaporated. Clear when mixed with water (absence of oils and resins). No unpleasant smell when evaporated from filter paper (absence of fusel oil and allied bodies); and it must respond to other tests given in the Pharmacopœia.

Alcohol (90 per cent.) is only slightly stronger than rectified spirit, B. P. 1885, containing 1·35 per cent. more alcohol. On mixing alcohol and water, contraction of volume and rise of temperature occur. When such a mixture is prescribed, the cooled liquid should be employed.

The four official liquids obtained by diluting alcohol (90 per cent.) with distilled water are:—

3. Alcohol (70 per cent. *by volume*) = 1000 millilitres alcohol (90 per cent.) + 310·5 millilitres distilled water. Sp. gr. 0·8899.

4. Alcohol (60 per cent. *by volume*) = 1000 millilitres alcohol (90 per cent.) + 536 5 millilitres distilled water. Sp. gr. 0·9134.

5. Alcohol (45 per cent. *by volume*) = 1000 millilitres alcohol (90 per cent.) + 1053·4 millilitres distilled water. Sp. gr. 0·9435.

6. Alcohol (20 per cent. *by volume*) = 1000 millilitres alcohol (90 per cent.) + 3558·0 millilitres distilled water. Sp. gr. 0·9760.

7. Vinum Xericum.—Sherry.

Characters.—A Spanish wine. Pale yellowish-brown colour. Contains not less than **16** per cent. *by volume* of **ethylic alcohol,** with oils, colouring matters, &c., and water. Used to make all Vina except the two made with orange wine.

8. Vinum Aurantii.—Orange Wine.

Source.—Made by fermentation of a saccharine solution to which the fresh peel of bitter orange is added.

Characters.—Contains from **15** to **17** per cent. *by volume* of **ethylic alcohol.** Used to make Vinum Ferri Citratis and Vinum Quininæ.

Amount of Ethylic Alcohol by Volume in various important Substances.

Alcohol Absolutum	contains	99	per cent.
Alcohol (U.S.P.)	"	94	"
Spiritus Rectificatus	"	90	"
Alcohol Dilutum (U.S.P.)	"	64·5	"
Whisky	"	51 to 59	"
Rum, Gin, Strong Liqueurs	"	51 to 59	"
Spiritus Tenuior (Proof Spirit) *	"	57·09	"
Spiritus Vini Gallici	"	43 to 57	"
Port	"	20 to 30	"
Vinum Album Fortius (U.S.P.)	"	23 to 29	"
Sherry and Madeira	"	16 to 22	"
Vinum Album (U.S.P.)	"	12 to 14	"
Champagne	"	10 to 13	"
Vinum Aurantii	"	10 to 12	"
Burgundy	"	9 to 12	"
Hock	"	9 to 12	"
Claret	"	8 to 12	"
Cider	"	5 to 9	"
Strong Ale or Stout	"	5 to 9	"
Beer and Porter	"	2 to 5	"
Koumiss	"	1 to 3	"

Action.

External.—Alcohol is an excellent cutaneous antiseptic, because dissolving fats it enters the sweat and sebaceous ducts. It quickly evaporates. It therefore cools the skin, which consequently becomes pale from the contraction of the small vessels; owing to this less sweat is secreted. Alcohol is thus refrigerant, astringent, and anhidrotic. But if

* Proof Spirit is defined by Act of Parliament as "being such as shall, at a temperature of 51° F., weigh exactly $\frac{12}{13}$ part of an equal measure of distilled water." Weaker spirits are termed "under proof," and stronger spirits "over proof." Thus 25 degrees over proof means a mixture of alcohol and water in such proportion that 100 volumes of this mixture, when diluted with water to make the mixture proof spirit, yields 125 volumes of proof spirit; and 25 degrees under proof means a mixture of proof spirit and water containing in 100 volumes 75 of proof spirit and 25 of water.

evaporation is prevented in any way, such as by a watch-glass or a piece of gutta percha, or the alcohol is rubbed in, it quickly absorbs water from the skin, and thus hardens it. Having passed through the epidermis it dilates the vessels, causes a feeling of warmth, and produces a rubefacient effect. It coagulates albumen, but the coagulum quickly redissolves. It extracts water from all tissues and is a valuable solvent of vegetable drugs.

Internal.—*Mouth.*—When concentrated, alcohol produces a feeling of warmth, or often even a burning sensation, in the mouth. If held there for some time the albumen of the superficial tissues is coagulated, and the mucous membrane becomes white, congested, and opaque, but this appearance soon disappears, as the coagulum is redissolved by the fluids of the tissues. Directly the alcohol is put in the mouth there is an increased flow of saliva and gastric secretion, and the pulse may be quickened; these results are reflex, but after absorption small amounts stimulate, large amounts depress the secretion of saliva. Alcohol has a slight local anæsthetic effect.

Stomach.—Here also, if the alcohol is sufficiently concentrated, there is a sensation of warmth or even of burning. If only small quantities are given, the gastric vessels dilate and there is an increased secretion of gastric juice. All this can be seen in cases of gastric fistula. The result is that the appetite is sharpened, and this explains the custom of taking a little alcohol immediately before meals, and also the common experience that alcohol taken during meals aids digestion. These effects are enhanced by the bitters in beer and the ethereal esters in wines. Alcohol does not increase the activity of the gastric movements, but promotes absorption. Thus there are several ways in which moderate doses of alcohol may help the digestive process, and Binz has actually

demonstrated, by removing the gastric contents at stated times after a meal, that alcohol aids digestion, and by giving potassium iodide he showed that it increased the rapidity of absorption. In some cases it produces local anæsthesia in the stomach, and so it may relieve gastric pain. It is to a slight extent decomposed into aldehyde and acetic acid, and consequently some of the pepsin, peptones, and proteids are precipitated. This hinders digestion, but usually not sufficiently to outdo the aid due to the vascular dilatation, the increased secretion, and the increased absorption. The effect of large doses is very harmful. The activity of the gastric juice is destroyed, the gastric walls are inflamed, large quantities of mucus are poured out, and if the over-indulgence is continued chronic gastritis ensues, the gastric glands atrophy, and consequently we get the permanent dyspepsia of drunkards.

A single dose of alcohol introduced into the stomach in a concentrated form, *e.g.* neat brandy, immediately produces important reflex effects. The heart beats more rapidly and more forcibly, the vessels of the whole body dilate, especially those of the skin; hence there is a feeling of warmth. The blood-pressure rises. These reflex effects are well seen in the immediate restoration of a fainting person by the ingestion of a single dose of brandy. Dilute alcohol, *e.g.* beer, does not produce them. They are quickly followed by the effects of alcohol upon the circulation due to its presence in the blood after absorption.

Intestines.—Here alcohol has a slight astringent effect, and consequently it may check diarrhœa. It acts on the pancreatic as on the salivary secretion.

Blood.—It is absorbed quickly, from the stomach and small intestine, none reaching the large. It appears in the blood in five minutes and reaches its maximum concentration in one and a half hours.

Temperature.—Alcohol is antipyretic, lowering the temperature in fever, and with large doses in health. This is chiefly due to cutaneous vascular dilatation and rapidity of circulation, but also to depressing the heat-regulating centre.

Metabolism.—Almost all the alcohol taken is oxidized in the body, and a litre of Rhine wine of average strength produces as much heat as five or six tablespoonfuls of olive oil, and an ounce of brandy yields 100 calories of energy. Neither the intake of oxygen nor the output of carbonic acid gas is altered by alcohol, therefore it saves the tissues and is a food. Repeated observations have shown the proof of this, for although moderate doses of alcohol by their toxic action at first increase protein metabolism, yet in a few days they diminish the output of urea and uric acid 6 or 7 per cent., and by their oxidation protein tissues are spared; and that it is a food is also proved by the fact that the weight of the body may be maintained if a large amount of alcohol is taken, even if the rest of the food is very small in amount. It will be noticed that it is a food which can be absorbed without any previous digestion.

The diminished oxidation of tissues being much more marked in fatty than in protein tissues, may, in habitual drinkers of large quantities of alcohol, lead to an imperfect combustion of fat, consequently it accumulates in the tissues, and obesity, which is often increased by the amount of saccharine matters that alcoholic liquids contain, results. The skin acquires a velvety feeling.

With moderate doses, very little alcohol leaves the body in the urine, as it has been oxidized; with large doses the case is different.

Circulation.—The effects upon the circulation reflexly produced by stimulation of the mouth and stomach have already been mentioned. After alcohol is absorbed it influences the heart but slightly.

In the case of a few persons it beats more powerfully and rapidly and the pulse is fuller. The cutaneous vaso-motor system is almost always acted upon, the vessels of the skin dilate; therefore, if he previously felt cold, the person who has taken the alcohol feels warm and the skin perspires. The blood-pressure is but little altered. The person who has taken the alcohol usually feels generally better for it. This is by no means always so; some persons have a headache or feel very sleepy immediately after alcohol. This is chiefly due to its depressant action on the central nervous system, but perhaps partly because the vessels of the abdomen or skin have dilated so excessively that almost all the blood in the body is in them, and consequently there is very little in the brain. There are many individual peculiarities in the effects of alcohol.

It has been repeatedly proved that these good results are but transitory. The heart, even if at first stimulated, is more exhausted after the stimulation has passed off than it was before. This is true also of all the organs of the body stimulated by the increased circulation induced by alcohol. In many campaigns and Arctic expeditions it has been found that although at first the men, after taking alcohol, could do more work, yet soon they felt so tired and exhausted, that on the whole they could do much more without than with the alcohol. Large doses of alcohol do not stimulate the heart at all; they paralyse it, both reflexly from the stomach and after absorption. Enormous doses poured into the stomach kill almost immediately by reflex action. A drunkard who is "dead drunk" is, accurately speaking, one who is killed by the paralysing effect of alcohol on the heart, but the phrase is often applied to any one who is very drunk.

Respiration.—The rapidity of respiration and the amount of air breathed are very slightly increased

by ordinary doses of alcohol, both reflexly and by stimulation of the respiratory centre. Very large doses depress it.

Skin.—Alcohol is a mild diaphoretic, partly because of its vaso-dilator action, and perhaps also because of some direct influence on the sweat-glands. As just mentioned, the cutaneous vascular dilatation leads to a feeling of warmth if the patient's cutaneous vessels were previously contracted from cold. If a person is in a cold atmosphere, alcohol, by depressing the heat regulating centre and by increasing the radiation from the skin, leads to the loss of so much heat that he may die from cold, although at first the increased cutaneous circulation, making him feel warmer, gives him a delusive feeling of warmth.

Kidneys.—About 2 per cent. of the alcohol ingested—unless very large quantities are taken—is excreted unchanged, mostly in the urine, to a less extent in the expired air, only the merest trace in sweat, and none in the milk or fæces. Most of it is oxidized in the body. It acts as a mild diuretic; this is chiefly a secondary result of its vascular effects, but it probably also acts directly on the glomeruli.

Nervous system.—Some have said that this is, by small doses, transitorily and slightly stimulated, *but the main* effect of alcohol on the nervous system is depressant to all its parts. In small doses it is thus beneficial, for the person who has taken it is not worried by trifles, and if shy is less self-critical, therefore he feels more comfortable and may make an after-dinner speech with more confidence. The highest functions are first affected, and their depression leads the person who has taken the alcohol to talk more fluently and brilliantly and his wits are sharpened. If the dose has been large, the stage of depression of all functions quickly appears, the highest functions being affected first, and the depres-

sion of function proceeds regularly from the highest to the lowest. The action of alcohol thus illustrates both the fact that stimulation is usually succeeded by depression, and also the "law of dissolution," which (p. 108) states that functions which have appeared latest in the animal series of the individual are the most easy to influence, those which have appeared earlier are less easy to influence; and so by regular sequence till we arrive at those functions which are first developed, which are the last to be influenced. The depression of function therefore proceeds in a descending scale from the highest or least firmly fixed function to the lowest or most firmly fixed. Thus the power of judgment is abolished very early by alcohol; this is so while the imagination, the emotions, and the power of speech still remain vivid; but soon the power of imagination goes, the patient loses all command over his emotions, he cries and laughs irregularly, but this soon stops. He next begins to lose control over his speech, talking incoherently and thickly; shortly afterwards he cannot talk at all, but can only make a noise. Muscular movements, which are not so highly developed as those of speech, are next affected; delicate, lately developed movements, as writing or feeding himself, are for a time performed incoordinately, but soon they are paralysed. Next the muscular movements developed before these are implicated, and the patient cannot undress himself or walk straight, and incoordination of these movements passes into the inability to do them at all. Next the activity of the reflex centres of the cord is abolished, the patient passes his urine and fæces under him. Then the respiratory centre becomes paralysed, breathing is difficult, and the face is livid. Lastly, the heart is paralysed, and the patient dies. The depression of the reflex centres of the cord accounts for the fact that injuries which would kill a

sober man do not kill a drunken one, for the heart and respiration, owing to the general central depression, are not affected reflexly by them. It must be remembered that with alcohol and drugs of similar action (*e.g.* chloroform) the apparent stimulation of nervous centres is really due to depression of inhibition, so their action is entirely depressant. All nervous depression is believed to depend upon a retraction of the terminal filaments of axons and dendrons, thus rendering synapses less intimate.

Muscular system.—Although alcohol is a food, its depressant effect on the nervous system is quickly seen in the depression of the power to do work, and although experiments on animals show at first a slight direct stimulation of muscular powers, and with some persons small doses perhaps at first stimulate the power of work, any action in this direction is slight, and is quickly followed by a depressant effect.

Therapeutics.

External.—Four parts of rectified spirit to one of water form the Lotio Spiritus of many pharmacopœias. Rags or lint dipped in it are applied to sprained joints and bruises. The alcohol evaporates, cools the part, consequently the vessels contract, and inflammation may thus be checked. At the same time the local anæsthetic effect of the cold relieves the pain. In a similar way many varieties of headache may be soothed by bathing the forehead with either eau de Cologne or bay rum, which is the common name for Spiritus Pimentæ Co. B. P. C. and consists of oil of pimento leaves, 0·75 ; oil of orange peel, 0·05 ; oil of pimento, 0·05 ; alcohol, 64 ; kaolin, q.s. ; water to 100. Brandy or some other form of alcohol is often used to bathe the skin in order to harden it by abstraction of water, and thus prevent the

formation of bedsores or cracked nipples. It is an excellent antiseptic for the skin. Spirit lotions dabbed on the skin may, by means of the local vascular contraction produced, stop sweating. Alcohol rubbed in, as in the use of Linimentum Camphoræ Ammoniatum, is commonly employed for its rubefacient effect, to aid the absorption of inflammatory products and to relieve pain, as in chronic rheumatism and myalgia.

Internal.—*Mouth.*—A little brandy held in the mouth will be a local anæsthetic and relieve toothache. Alcohol is used as a gargle of port wine for its power of precipitating albumen and acting as an astringent in cases of chronic sore throat, excessive salivation, or inflammation of the gums.

Stomach.—Because it increases the secretion of gastric juice, the vascularity and absorption from the stomach, alcohol aids digestion. It must only be taken in small quantities, for large amounts paralyse the secretion and cause gastritis, and ultimately lead to atrophy of the gastric glands. It should be given just before or during a meal. It is harmful in acute dyspepsia, but for the indigestion of the aged and feeble, or for those who are thoroughly exhausted by overwork, it is very valuable, as the stomach shares in the general exhaustion. It is also useful because it increases the appetite, and it is a food which is absorbed without previous digestion. Owing to its anæsthetic property it may relieve painful dyspepsia, and may check vomiting, especially if taken with carbonic acid gas, as, for example, in the form of champagne or brandy and soda-water, and frequently, if concentrated, it will relieve flatulence. A single dose of strong spirits poured into the stomach is often employed with great benefit for its reflex stimulant effects on the circulation for those who have fainted, or who are collapsed from cold or any other cause.

Intestines.—Brandy and water may check diarrhœa. Perhaps this is owing to the astringent power of the brandy.

Fever.—Alcohol has been largely used in all sorts of febrile conditions. We have seen that it is a narcotic and soothes the central nervous system, that it impairs oxidation, that it is oxidized and is therefore a food, that as a food it has a high caloric value, that it saves protein tissues, that it can be absorbed without taxing digestion, and that it is mildly antipyretic and diaphoretic. These properties would render it beneficial in fever. On the other hand, any acceleration of the pulse would be distinctly harmful, although it must be remembered that often, by its action on the central nervous system, alcohol lowers the pulse in fever; the indigestion and the liability to depression of the respiratory and cardiac centres, caused by the taking of large quantities, would be very undesirable. The best rules are that while alcohol may be given often with advantage in fever, either to aid digestion, to slow the pulse, as a cardiac stimulant if the patient be much collapsed, or to produce sleep, yet it may in any of the ways alluded to do harm. Therefore, when it is being used the effect must be carefully watched, and if the pulse becomes quick and feeble, or, as indicating gastric irritation, the tongue becomes dry and brown, or the skin becomes hot and dry, or the breathing hurried, or the patient suffers from insomnia, the alcohol should be stopped. On the other hand, if the pulse becomes stronger and slower, the tongue and skin moist, the breathing tranquil, and the patient sleeps well, the drug is doing good, and may be continued. We have so many more powerful diaphoretics and antipyretics that alcohol is not often given for these purposes. Of all fevers it is most used for acute pneumonia, and it is most likely to be valuable when our object is to soothe the central nervous system, to make the

patient comfortable and peaceful for a few days till the end of a short specific fever; but it is often given when it is quite unnecessary.

Nervous system.—Alcohol may, as just mentioned, be used as a soporific in fever. Many sufferers from insomnia find that they sleep better for a glass of whisky and water at bedtime, because of its depressant action upon the highest centres, and this makes it of great use in any illness in which the patient is worried by trifles.

Kidneys and Skin.—Alcohol is occasionally given as a diuretic. Gin is the best form, because it usually contains some juniper, which is also diuretic. Although but little alcohol is excreted by the kidneys, it seems to be particularly irritant to the urethra in cases of gonorrhœa and gleet, and some authorities consider that chronic Bright's disease may be induced by alcohol. Almost the only use made of its diaphoretic effect is as a help to cure a cold in the head, for which purpose a strong glass of spirits and warm water may be taken immediately before going to bed.

Toxicology.

Large doses of alcohol will produce death, either instantly by reflexly stopping the heart, or later by cardiac and respiratory depression after absorption.

Chronic poisoning causes so many diseases that it is really a part of medicine. Very often confirmed drunkards, particularly if they take much spirits, are very thin; this is probably due to the fact that strong spirits cause such marked indigestion that no nourishing food is absorbed. Other drunkards are fat, especially if they drink beer. Chronic gastritis, cirrhosis of the liver, gout, peripheral neuritis, delirium tremens, mania, and perhaps chronic Bright's disease, are all directly due to excessive indulgence in alcohol. It renders patients particularly liable to phthisis, and makes them bad subjects for withstanding any severe illness, especially pneumonia. Alcoholic beverages contain other bodies than alcohol, which are probably partly responsible for these evil effects.

CHLOROFORMUM.

Chloroform is Trichloromethane, $CHCl_3$, to which 2 per cent. of absolute alcohol has been added.

Source.—Obtained from ethylic alcohol, methylated spirit, or acetone by heating with chlorinated lime, slaked lime, and distilled water and subsequent purification. Should be kept in a cool and dark place.

Characters.—A colourless, volatile, heavy liquid, sp. gr. between 1·483 and 1·487, of a sweetish taste and a peculiar odour. It imparts a green colour to flame. *Solubility.*—1 in 200 of water, in which it sinks in heavy drops; 10 in 7 of alcohol (90 per cent.); freely in ether, olive oil, or turpentine.

Impurities.—Hydrocarbons, shown by darkening with sulphuric acid; non-volatile compounds, shown by not completely evaporating, and by unpleasant odour; acids; free chlorine.

Tests for Purity.—(*a*) It must not redden blue litmus; (*b*) nor render cloudy silver nitrate; (*c*) nor give blue colour with cadmium iodide and starch; (*d*) nor turn yellow when agitated for one hour with H_2SO_4.

Dose, 1 to 5 m. internally—6 to 30 centimils.

Preparations.

1. **Aqua Chloroformi.**—Chloroform, 2·5; dissolved in water, 1000.
Dose, ½ to 2 fl. oz.—15 to 60 mils.

2. **Linimentum Chloroformi.**—Equal parts of chloroform and camphor liniment.

3. **Spiritus Chloroformi.** *Synonym.*—Chloric ether. Chloroform, 1; alcohol (90 per cent.), 19 *Strength.*—1 in 20.
Dose, 5 to 20 m.—3 to 12 decimils—for repeated administration, **30 to 40 m.—20 to 25 decimils**—for a single administration.

4. **Tinctura Chloroformi et Morphinæ Composita.**—Intended to be an imitation of the proprietary medicine called chlorodyne. Mix chloroform, 75, tincture of capsicum, 25, tincture of Indian hemp, 100, oil of peppermint, 2, and glycerin, 250, with alcohol (90 per cent.), 450. Dissolve morphine hydrochloride, 10, in the mixture. Add to it diluted hydrocyanic acid,

50, and enough alcohol (90 per cent.) to make 1000. *Strength.*—1 millilitre contains chloroform, 7·5 centimils; morphine hydrochloride, 1 centigrm.; acidum hydrocyanicum dilutum, 5 centimils. 10 ♏ contains chloroform, $\frac{3}{4}$ ♏; morphine hydrochloride, $\frac{1}{11}$ gr.; acidum hydrocyanicum dilutum, $\frac{1}{2}$ ♏.

Dose, 5 to 15 m.—3 to 10 decimils.

N.B.—This preparation is very nasty, and not at all like chlorodyne. Martindale's Liquor Chloromorphinæ is a better imitation, and contains chloroform, morphine, atropine, and oil of peppermint for active ingredients. Its dose is 5 to 15 ♏.

Action.

External.—Chloroform in many respects acts like alcohol, but it is more powerful. Thus if allowed to evaporate on the skin it produces cold; therefore the vessels at the point of application contract, and at the same time local anæsthesia is induced. If the vapour be confined, or if chloroform be rubbed into the skin, it acts as an irritant. The vessels dilate, the part becomes red, and there is a sense of heat. This rubefacient effect may pass on to vesication. It is a powerful antiseptic and general protoplasmic poison.

Internal.—*Mouth.*—If concentrated, it produces irritation and a burning sensation. If dilute, it has a sweetish taste, which renders Aqua Chloroformi a valuable vehicle for the administration of nauseous drugs. It reflexly gives rise to an increased secretion of saliva, and is a local anæsthetic.

Stomach.—The action of chloroform is very like that of alcohol. Large doses cause marked gastro-intestinal irritation. Small doses produce a feeling of warmth, dilatation of the gastric vessels, an increased secretion of gastric juice, and more regular and more powerful gastric movements. It is perhaps slightly astringent to the intestines.

Absorption.—It is absorbed into the blood from the stomach and intestines, and, if given as vapour, from the lungs, but it is very uncertain what changes it subsequently undergoes. Probably most of it is combined with the cholesterin and lecithin of the red corpuscles, but some is certainly eliminated in the breath and some in the urine; it may be found in the blood of those who have been poisoned by it, and glycuronic acid may appear in the urine.

Temperature.—The temperature falls about 1°F. after the prolonged administration of chloroform.

Metabolism.—After its administration the nitrogen and sulphur in the urine are increased, indicating a greater destruction of protein. The chlorides in the urine, too, are increased, showing that some chloroform is decomposed in the body. If the patient be suffering from diabetes, the sugar in the blood and urine is much increased. Repeated inhalation of chloroform produces fatty degeneration, especially of the liver, heart, and kidneys, and prolonged over-indulgence leads to fibrosis of the same organs.

Excretion.—This takes place mainly by the lungs.

Nervous system.—Chloroform is an excellent instance of the law of dissolution (*see* p. 108), and also of the well-known fact that drugs which in small doses appear to stimulate any part, in large doses often depress it. The phenomena resulting from the inhalation of chloroform are commonly divided into three stages. Here, as with alcohol, it is an open question whether the symptoms of stimulation are due to removal of inhibition or to direct stimulation.

First stage.—This is at first one of general stimulation, the highest functions being the most stimulated, usually unevenly, so that the patient is somewhat incoherent. The imagination is momentarily excited, and he experiences a general feeling of warmth and comfort spreading over the entire

body. The mind, from the irregular excitation, is confused. Sight and hearing are stimulated, he experiences sensations of light and hears noises. The stimulation of all these higher functions is very transitory, and he quickly begins to lose consciousness; he may be aware that people around him are talking without knowing what they are saying, but soon he hears and sees nothing. Sometimes during the early part of this stage he may laugh or cry. The inability to see and hear is quickly followed by considerable blunting of general sensation. At the same time that these higher functions are being depressed the lower motor functions are excited; he will kick and fight, throwing his arms and legs about, so that much strength may be required to hold him down, and he will shout and talk incoherent nonsense very loudly. Almost coincidently the stimulation of the lower centres sets in; the pulse is increased in frequency, and there is throbbing of the heart and great vessels. The first inhalation or two may produce a choking sensation and an arrest of breathing, which is often voluntary; but soon the respirations are increased in frequency. The blood-pressure at first rises a little, and the face may be flushed. The pupils usually dilate.

Second stage.—This is best called that of depression. Some authors call it the stage of excitement, because the excitation of the motor centres may be continued into it. It is important to remember that there is no sharp boundary line between the various stages; they pass insensibly into one another. In this stage the depression of the highest functions continues, so that the patient becomes completely unconscious, and he appears to be in a deep sleep. He sees, hears, and feels nothing; hence chloroform is called a general anæsthetic. The excitement of the motor functions passes into depression, and he ceases to shout and

struggle. Some of the reflex centres are depressed, so that when the cornea is touched the eye does not shut. The pupil is contracted. The stimulation of the cardiac and respiratory apparatus gives way to depression, the pulse and respirations become less frequent and less strong. The vaso-motor centre is depressed, blood-pressure falls. As he cannot feel pain, and the reflex activity is so lowered that the heart will not be reflexly inhibited by the shock of an operation, this is the period at which to operate safely.

Third stage.—In this there is a total abolition of reflex excitability. Even the lowest reflex centres of the cord are depressed, so that the patient may pass his urine and fæces under him; all muscular tone is abolished, and consequently the muscles are quite flaccid. Some of them, as those of the arm, were probably in this condition towards the end of the second stage. The pupil is widely dilated, probably because of the commencing asphyxia. This is the period to which the administration is pushed to facilitate the reduction of dislocations, or to enable the abdominal viscera to be felt through the abdominal wall. If still more chloroform is given, the depression of the cardiac, respiratory, and vaso-motor centres continues, the pulse becomes feeble and irregular, and the heart finally stops in diastole. At last not only its central nervous apparatus but its muscular tissue is depressed by the direct action of the chloroform circulating in the coronary arteries, so that it will not respond to mechanical stimulation, and by this period it is so dilated that, if the pericardium is cut, the heart protrudes like a hernia. The unstriped muscle of the arteries is also depressed, and they dilate. The respiratory movements become slight and irregular, with very long pauses between them, and as a result the patient is more or less asphyxiated. The blood-pressure gradually falls to zero. There has been much dispute as to whether

chloroform kills by the heart or the respiration. The Commission appointed by the Nizam of Hyderabad reported that it killed by depression of the respiratory centre, that respiration always failed before the heart, and that the fall of blood-pressure was not due to any effect on the heart. But it has since been shown that chloroform suddenly kills by the heart owing to the production of auricular fibrillation, and to a less extent to stimulation of the vagus centre in the medulla, and that the fall of blood-pressure is due to effect on the heart, and to a less extent to depression of the vaso-constrictor centre. The depression of respiration is the result of the fall of blood-pressure.

The recovery from chloroform also illustrates the law of dissolution. The lowest functions, such as muscular tone, are the first to reappear; but the patient does not usually regain his mental equilibrium for hours. Chloroform and many drugs of the methane series are especially soluble in lipoids, and this fact has been used to explain their narcotic action (*see* p. 111).

With the exception of its local actions on the skin and alimentary canal, and its later effect on the cardiac muscle, and that on the vessels, chloroform acts entirely on the central nervous system, and this action is not the result of any effects on the blood. The peripheral nerves are not affected, unless it be just before death. Chloroform narcotizes infusoria.

Vomiting is very liable to occur during the administration of chloroform, and its advent is often made known by pallor and wide dilatation of the previously contracted pupil. Immediately before death the pupil may be either dilated or contracted.

Therapeutics.

External.—Chloroform is employed in the form of a liniment to produce rubefacient and irritant

effects in cases of chronic rheumatism, myalgia, and chronic inflammations. A drop of chloroform to the fluid ounce of urine or of animal and vegetable infusions or decoctions will keep them from decomposition.

Internal.—It may be used as a local anæsthetic for toothache, the tooth being plugged with a piece of cotton wool soaked in chloroform. It disguises the taste of nauseous medicines, and therefore Aqua Chloroformi is a very common vehicle, and Spiritus Chloroformi is much used as a flavouring agent. In the stomach it acts like alcohol, and is given in the same varieties of dyspepsia as are benefited by that drug. Small doses may be used as cardiac stimulants.

Inhalation.—It is inhaled to abolish sensations of pain, whether from surgical operations, biliary, renal, and intestinal colic, or parturition. In the last case not much need be given. It is also inhaled to relax muscular spasm, as in the reduction of dislocations or herniæ, or for the relaxation of muscles for diagnostic purposes, as, for example, when we wish to feel the abdominal viscera thoroughly, or to see whether a swelling is a phantom tumour; or, lastly, it is inhaled to relax spasm in cases of tetanus, hydrophobia, or in other varieties of convulsions, as chorea. The A.C.E. mixture, which consists of absolute alcohol 1 vol., chloroform 2 vols., and pure ether 3 vols., is very commonly employed for all these purposes. It is said to be safer than chloroform. All its three constituents volatilize from it at an equal rate.

The following points should be attended to in the administration of chloroform:

1. The respiration and pulse should be carefully watched for any signs of failure.

2. The operation should never be begun till reflex action is profoundly depressed—that is to say till the stage of muscular relaxation has commenced. Many patients have been lost from neglect of this precaution, for the stimulus of the knife has reflexly

stopped the heart. It is a common and dangerous error to think that, because the operation is trivial, it may be begun early; most of the deaths from chloroform have taken place early and when the operation has been slight.

3. Great care must be exercised if the heart be fatty or feeble from any cause, or if the patient suffer from disease of the lungs, or if he be very old.

4. In operations about the mouth care must be taken to see that no blood gets down the trachea.

5. It is desirable to have the stomach empty, therefore no solid food should be given for some hours before the administration. The patient's head must be so directed during vomiting that no vomited matters can get into the larynx.

6. False teeth should be taken out of the mouth.

7. The chloroform must be pure.

8. It should not be too concentrated, for if it is, the heart may suddenly stop owing to stimulation of the vagal centre. This is the cause of many deaths. About 5 per cent. of chloroform to 95 per cent. of air is a good mixture.

9. The head should be a little raised, and the lower jaw held up so that the tongue shall not fall back over the larynx.

10. Special care must be taken when the operation necessitates awkward positions, especially if respiration is interfered with, as in the lateral position used in obstetric and renal cases.

11. Because the temperature falls the patient should be kept warm.

If the pulse fails or the breathing becomes very weak, or stops altogether, artificial respiration should at once be commenced, the tongue being pulled forward by forceps to allow free entry of air to the lungs. The face and abdomen should be flicked with wet towels, a capsule of amyl nitrite may be inhaled, and strychnine, ether, or brandy injected subcutaneously. It is doubtful whether galvanization over

the cardiac area is of any use; perhaps it does harm. Artificial respiration should be maintained at least an hour or so, even if there is no sign of returning life; and if there is the slightest evidence of a cardiac beat, or a single automatic respiratory movement, artificial respiration must be persevered in for even many hours. If the face be pale, the head should be lowered, and amyl nitrite is especially likely to be useful. Atropine may be injected into a vein in the hope of accelerating the pulse slowed by action of the chloroform on the vagal centre. The heart has been restarted by opening the abdomen and compressing it through the diaphragm (see p. 114).

Delayed Chloroform Poisoning.—Occasionally repeated and very rarely a prolonged single administration leads to grave disorders of metabolism. The liver and (to a less extent) other organs become fatty, the urine indicates increased protein destruction, and carbohydrate metabolism is impaired. The symptoms of acidosis are present. Diabetes is made more severe by chloroform, which should not be used as an anæsthetic for sufferers from this disease.

Bromoform.—$CHBr_3$. (Not official.)

Characters.—A limpid, colourless, sweet liquid, soluble in alcohol, very slightly in water.

Dose, ½ to 2 m.—3 to 12 centimils.

Action and Therapeutics.

Bromoform is used for whooping-cough. It diminishes the severity and number of the paroxysms. Many cases of poisoning are on record, for it is almost insoluble in water, and having a sp. gr. of 2·9 it sinks to the bottom of a mucilage mixture, and is all taken in the last dose. This is best got over by dissolving it in alcohol. Thus: bromoform 2, alcohol (90 per cent.) 7·5, glycerin 30. This will mix with water, and most other drugs, without precipitating the bromoform, and may be flavoured with orange and cardamoms as in Elixir Bromoformi (B. P. C.). Dose, ½–2 fl. dr. (2 to 8 mils). Bromoform may be suspended in a mucilage mixture if dissolved in thrice its volume of almond oil. The symptoms of poisoning are the same as those of chloroform.

ÆTHER.

Ethylic Ether, or Ethyl Oxide. $C_4H_{10}O$.
Synonym.— Sulphuric ether.

SOURCE.—Prepared by distilling a mixture of ethylic alcohol or industrial methylated spirit with sulphuric acid, and rectifying the distillate.

CHARACTERS.— A colourless, light, volatile liquid, with a hot taste and peculiar odour. It is very inflammable, boils between 34° and 36°C., and burns with a white flame. Sp. gr. 0·72.

IMPURITIES.—Water, alcohol, and fixed impurities.

Dose, 15 to 30 m.—1 to 2 mils—for repeated administration; **45 to 60 m.—3 to 4 mils**—for a single administration.

Preparations.

1. Æther Purificatus.

2. Spiritus Ætheris.—Ether, 1 part; alcohol (90 per cent.), 2 parts. Sp. gr. 0·802 to 0·806.

Dose, 20 to 40 m.—12 to 25 decimils—for repeated, **60 to 90 m.—4 to 6 mils**—for single administration.

3. Spiritus Ætheris Compositus. (Not official, but official B. P. 1898 and often used.) *Synonym.*— Hoffmann's anodyne. Mix sulphuric acid 36 fl. oz. with alcohol (90 per cent.), 40 fl. oz. A complex ethereal compound called oil of wine is formed. It is chiefly ethyl hydrogen sulphate, and is thus produced: $C_2H_5{\cdot}OH + H_2SO_4 = C_2H_5{\cdot}HSO_4 + H_2O$. After twenty-four hours slowly distil the mixture. The distillate contains water, sulphur dioxide, ethylene, and a little oil of wine. Add water to the upper layer of distillate after it is removed from the lower, then shake it with sodium bicarbonate to neutralize the acid. Separate the ethereal liquid, which consists chiefly of oil of wine, add to it ether, $5\frac{1}{2}$ fl. oz., and alcohol (90 per cent.), 38 fl. oz.

Dose, 20 to 40 m.—12 to 25 decimils—for repeated, **60 to 90 m.—4 to 6 mils**—for single administration.

Action.

External.—Ether evaporates very quickly, producing **great** cold, and consequently the part to which it has been applied becomes white from the contraction of the vessels. The cold is sufficient to cause such marked **local anæsthesia** that very slight operations may be performed upon the part anæsthetized. To produce this result ether is best applied as a fine spray. If it be rubbed in, or evaporation be prevented, it, like alcohol or chloroform, is an **irritant.**

Internal.—In the mouth and stomach also it acts like **chloroform** or **alcohol.** Thus ether causes a burning taste in the mouth, an increase of the saliva, of the gastric secretion and gastric movements, and dilatation of the vessels of the stomach. Consequently it is carminative and aids digestion. Directly it reaches the stomach it **reflexly** excites the heart, increasing the force and frequency of the pulse, and causing a rise of blood-pressure; it is one of the best **cardiac stimulants** we have. In the same way it excites respiration. It is quickly absorbed, and its stimulating influence on the heart and respiration is continued. It is thus a good instance of a rapidly diffusible stimulant. If a fatal dose is inhaled death is due to depression of respiration.

Nervous system.—Ether is a powerful **general** anæsthetic. The phenomena and stages of ether anæsthesia are so like those of chloroform anæsthesia that the description already given (p. 298) will suffice. The following differences, however, should be noticed:

(1) The heart is paralysed with much greater *difficulty by ether than by chloroform.*

(2) The same is true of the vaso-motor centre.

(3) And also of the respiratory centre.

(4) Ether is much more irritant to the respiratory mucous membrane, and hence is more liable to increase bronchitis in those already suffering from it.

(5) With ether the stage of stimulation is more protracted, therefore there is more struggling.

(6) For the same reason the anæsthetic stage is not reached so soon.

(7) Fall of temperature is greater with ether.

(8) Ether must be given nearly pure, about 30 per cent. of air to 70 of ethereal vapour; hence it is more difficult to administer.

(9) The smell of ether is more disagreeable, and patients dislike it more.

(10) Ether is eliminated more slowly, and hence the smell hangs about the patient some time.

(11) Ether being very inflammable cannot be used in the close neighbourhood of a naked light.

(12) With ether there is no risk of delayed poisoning as with chloroform.

Therapeutics.

External.—Ether, allowed to evaporate, may be used to cause local anæsthesia in cases of neuralgia. An ether spray is occasionally employed to produce local anæsthesia for small operations; but as the ether makes the skin hard and brawny the operation must be quite superficial, and even then there is much subsequent tingling and pain.

Internal.—*Stomach.*—It may be used for the same classes of dyspepsia as chloroform or alcohol, and is often employed as a carminative to expel gas in flatulent dyspepsia.

Heart.—Administered subcutaneously (dose, 10 to 15 ♏, 6 to 10 decimils) or by the mouth, ether is an excellent cardiac stimulant of great value in fainting, cardiac failure, or palpitation, its advantage over chloroform and alcohol being that it is more rapid in its action. It is very useful as an antispasmodic during an attack of asthma. Spirit of ether with an equal part of aromatic spirit of ammonia and some water forms an excellent restorative.

Inhalation.—Ether is inhaled for the same purposes, and with the same precautions, as chloroform. All the published statistics in which the two are contrasted appear to show that ether is much safer, and this is what might have been expected from the contrast between the two already given. Chloroform is administered carelessly more often than ether, as it is easier to give, but even allowing for this ether is safer unless given to those suffering from bronchitis. The nausea and vomiting which sometimes follow the administration of ether may, it is said, be checked by giving 15 grains of sodium bromide. Very often anæsthesia is commenced with a few inhalations of nitrous oxide gas, and then completed with ether. This is much pleasanter for the patient than to use ether from the first.

ETHYL CHLORIDE.

Ethyl Chloridum.—C_2H_5Cl. *Synonyms.*—Hydrochloric ether, Kelene.

Source.—May be obtained by the action of hydrochloric acid on ethylic alcohol, or on industrial methylated spirit.

Characters.—Gaseous at normal temperature and pressure, but as usually supplied is condensed into a colourless, mobile, inflammable, very volatile liquid.

Uses.

This substance has a low boiling-point, and produces intense cold by its evaporation. It is sold in glass capsules terminating in a fine tube with a screw-capped point. When the capsule is held with the fine tube pointing towards the part to be anæsthetized, at about eight inches from it, the liquid ethyl chloride by its own vapour pressure is forced out as a fine jet, which impinges on the skin of the patient, and by its evaporation produces enough local anæsthesia for the performance of small operations, such as the removal of small warts All fat must be removed from the skin by soap and washing

with ether. Ethyl chloride is inflammable. It may be given by inhalation as a general anæsthetic.

Methyl Chloride (Not official) is used in the same way for local anæsthesia and to relieve neuralgia.

Anestile (Not official) is a non-official mixture of methyl chloride and ethyl chloride, and is used in the same way as methyl chloride as a local anæsthetic.

Ethyl Bromide (Not official) is an excellent general anæsthetic for short operations requiring longer anæsthesia than that of nitrous oxide. No apparatus is required. *Somnoform* contains it with ethyl and methyl chlorides.

ÆTHER ACETICUS.

Acetic Ether.

A liquid obtained by distilling a mixture of ethylic alcohol, acetic acid, and sulphuric acid, and purifying the product. It contains not less than 90 per cent. of ethyl acetate, $C_2H_5C_2H_3O_2$.

Characters.—A colourless, fragrant liquid. Sp. gr. 0·9 to 0·907. *Solubility.*—1 in 10 of water; freely in alcohol or ether.

Dose, 15 to 30 m.—1 to 2 mils—for repeated administration; **45 to 60 m.—3 to 4 mils**—for a single administration.

Action and Therapeutics.

It acts like ether, as a stimulant, antispasmodic, and carminative, but has a pleasanter taste.

ACETONUM.

Acetone or Dimethyl-ketone, C_3H_6O.

Source.—May be obtained by the dry distillation of calcium acetate, or barium acetate.

Characters.—A colourless, transparent, mobile and volatile liquid. Characteristic odour. Taste pungent and sweetish.

It is used as a solvent for cantharidin in *Liquor Epispasticus*.

Action and Therapeutics.

Its action is almost the same as that of ethylic alcohol. It is a useful solvent for resins, fats, cantharidin, celluloid, &c. Hypnone is acetophenone or phenyl-methyl-ketone; it has been given as an hypnotic, but there are many much better.

NITROUS OXIDE.

Nitrous Oxide Gas. N_2O. (Not official.) *Synonym.*—Laughing Gas.

SOURCE.—Prepared by heating ammonium nitrate.

CHARACTERS.—A colourless, inodorous gas. It is supplied in the liquid form in steel cylinders under a pressure of 50 atmospheres. It is not chemically allied to other anæsthetics, but is considered here for convenience.

ACTION.

The gas is always administered by inhalation. Outside the body it supports combustion, but it is not of the same use to living tissues as oxygen, and if it replaces oxygen it leads to asphyxia owing to the absence of oxygen.

Nervous System.—When the gas is inhaled, the patient experiences, after a few seconds, a rushing noise in the ears, and indistinctness of vision. He feels he is losing control of his higher faculties; he has a great desire to laugh, and feels happy; his speech and other movements are incoordinate; respiration becomes difficult, and by the time inhalation has lasted about 30 seconds he is cyanotic, and the following additional evidences of asphyxia are often present, viz.: jerky, grunting stertor, muscular clonic twitchings, irregularity and finally stoppage of respiration. The face piece must be removed when cyanosis begins to appear, and it will be seen that there is no corneal reflex; the eyes are fixed, and the pupils dilated. The patient is also now completely anæsthetized, so that he does not feel a short operation, such as the withdrawal of a tooth. Very soon after the removal of the face piece he takes a deep breath, and the lividity disappears. The stage of anæsthesia lasts from 20 to 40 seconds, and after it the patient wakes in two or three minutes, and suffers from no after-effects.

It will be noticed that we have here the stage of excitation followed by depression. Whether the

excitation is due to direct stimulation of the central nervous system or to removal of inhibition is undecided. To some extent the gas depresses the nervous system by cutting off oxygen, but Bert showed that, if administered under increased pressure with oxygen, so that there was plenty of oxygen in the blood, anæsthesia was nevertheless produced; therefore the gas has a direct effect on the nervous system, possibly, as Dixon suggests, owing to its easy solubility in the fats there present.

Circulation.—Nitrous oxide has no direct influence on the heart. The rise of blood pressure and the slowness of the pulse are due to asphyxia. It is simply dissolved in the blood; the amount there corresponds to the partial pressure of the gas in the lungs.

Respiration.—The asphyxia is chiefly due to deprivation of oxygen, for the gas replaces much of that in the blood. The glycosuria that occasionally occurs after its administration is due to the asphyxia.

Therapeutics.

Nitrous oxide is used solely to produce anæsthesia for short operations. The steel cylinders in which the liquefied gas is contained have a tap which is worked by the administrator's foot. The liquid is vapourized directly it escapes from the cylinder, and it passes into a large indiarubber bag, from which the patient inhales it by a mask, with a valve so arranged that, while he can inspire from, he cannot expire into, the bag. It is found that if air, or still better oxygen, is inhaled at the same time as the nitrous oxide, we can produce the direct depressant effects of the gas on the central nervous system without the asphyxial symptoms, therefore pure nitrous oxide is rarely employed, but an apparatus devised by Hewitt, by means of which oxygen and nitrous oxide in varying proportions can be administered, is used; by it patients can be kept anæsthetized for a long while.

Class III.—Nitrites.

Spiritus Ætheris Nitrosi, Amyl Nitrite, Nitroglycerin, Sodium Nitrite, Ethyl Nitrite, Erythrol Nitrate.

All these dilate the peripheral vessels, and increase the rapidity of the heart.

SPIRITUS ÆTHERIS NITROSI.

Spirit of Nitrous Ether. *Synonym.*—Sweet spirit of nitre.

This is a solution in alcohol of several substances, the chief being ethyl nitrite, aldehyde, paraldehyde, acetic acid, and acetic ether.

Source.—Distil a mixture of alcohol (90 per cent.), nitric acid, sulphuric acid, and copper, and dissolve the distillate in alcohol (90 per cent.). Probably what happens is this:—Copper nitrate is first formed and hydrogen set free. This reduces some nitric acid to nitrous acid; this reacts with ethyl alcohol, forming ethyl nitrite and water. The copper nitrate first formed is decomposed by the sulphuric acid, nitric acid being regenerated and copper sulphate produced. The distillate consists of a mixture of ethyl nitrite, alcohol and its oxidation products.

Pure ethyl nitrite can be kept any time, but Spiritus Ætheris Nitrosi should be preserved in the dark in small hermetically sealed bottles, for it soon becomes acid. Much that is sold is not prepared according to the pharmacopœial directions.

Characters.—Transparent, nearly colourless, mobile, inflammable, slightly acid liquid of an apple-like odour and a sweet cooling taste. *Strength.*—According to the Pharmacopœia it must contain between 2·66 and 1·52 per cent. of ethyl nitrite. Sp. gr. 0·838 to 0·842.

Incompatibles.—Potassium iodide, iron sulphate, tincture of guaiacum, gallic and tannic acids, antipyrin, and emulsions.

Impurity.—Excess of acetic acid.

Dose, 15 to 60 m.—1 to 4 mils.

Action.

External.—Spirit of nitrous ether evaporates when it is applied externally, and a slightly anæsthetic effect is produced.

Internal.—It combines the action of the ether with that of the nitrites contained in it. Because of the ether it is a diffusible stimulant, a stomachic, and a carminative. Because of the nitrites it acts like amyl nitrite; but as the ethyl nitrite is so diluted, its action in this direction is feeble: thus it only moderately dilates the vessels, and except in poisonous doses probably does not affect the blood. The dilatation of the vessels leads to a diaphoretic effect on the skin, a diuretic effect on the kidneys, and a lowering of arterial blood-pressure. The dilatation of the cutaneous vessels, the sweating, and perhaps the changes in the blood, produce a slight antipyretic influence.

THERAPEUTICS.

For its diaphoretic and slight antipyretic effects it is commonly given in mild febrile attacks, such as a common cold. It is also used as a diuretic in chronic Bright's disease, and cardiac and pulmonary diseases accompanied by œdema.

AMYL NITRIS.

Amyl Nitrite.

SOURCE.—Produced by the interaction of nitrous acid and amylic alcohol that has been distilled between 128° C. and 132° C. It consists chiefly of isoamyl nitrite, $C_5H_{11}NO_2$, but also contains other nitrites of the homologous series.

CHARACTERS.—An ethereal liquid of a pale yellow colour, and smelling strongly like the sweetmeat pear drops, which are flavoured with amyl acetate. Sp. gr. 0·87 to 0·88. Very volatile. Soluble in ether, chloroform, or spirit, but not in water.

IMPURITIES.—Free acid and amyl nitrate.

Dose, 2 to 5 m.—12 to 30 centimils—cautiously inhaled from a handkerchief in which a glass capsule containing the nitrite of amyl has been crushed.

Action.

External.—Locally applied it diminishes the activity of the sensory nerves, but they quickly recover.

Internal.—Amyl nitrite is rarely given by the mouth, so the following account will refer to the effects of inhalation. The effects of a single inhalation pass off in two or three minutes.

Circulation.—From a medical point of view by far the most important effects of amyl nitrite are those produced upon the heart and vessels. Within a minute of inhalation the face flushes, the heart beats very rapidly and violently, there is a throbbing in the head, and the vessels, *e.g.* the carotids, may be seen to pulsate actively. Headache, giddiness, dilatation of the pupils, and increased respiratory movements quickly supervene. The vessels of the body rapidly dilate, but of the cutaneous vessels only those of the head and neck are affected, hence the flushing. The vessels may be actually seen to widen in the ear of a rabbit or in the retina. This is due to a direct action on the arterioles, for it happens if the cord is destroyed. It is the unstriped muscles of the arterioles, and not the ends of the nerves, which are affected. The blood-pressure and arterial tension of course fall very low. The increase in the rate of the pulse is unaccompanied by any alteration in the force of the beat; it is apparently due to a depressing influence on the inhibitory vagus centre, possibly as a result of lowered blood pressure. In toxic doses the heart may be arrested in diastole from direct action on the cardiac muscle.

Respiration.—The rapidity and depth of respiration are at first increased, from stimulation of the respiratory centre by the low blood pressure; this is later depressed, the breathing becoming

slower and shallower, and death occurs from asphyxia. Nitrites relax the bronchial muscles.

Nervous system.—Many of the symptoms referable to the nervous system are secondary effects of the dilatation of the vessels of the brain and spinal cord. Such are the throbbing, sense of fulness, giddiness, and headache noticed directly after inhalation. The headache may remain some time. If much has been inhaled there is unsteadiness of gait and general restlessness. The pupil dilates, and disturbances of vision are present. The motor centres of the cord are profoundly depressed, therefore after large doses reflex actions are abolished. The function of sensory nerves, motor nerves, and muscles is depressed by the local application of the drug to them, but not after inhalation until shortly before death.

Temperature.—Amyl nitrite causes this to fall both in fever and health. The fall is due to the peripheral vascular dilatation, and, if large doses are given, to the changes in the blood.

Urine.—The drug probably escapes in the urine as nitrites and nitrates; it is slightly diuretic, and may cause glycosuria, due, it is said, to dilatation of the vessels of the liver or of the medulla.

Blood.—Nitrites given in medicinal doses circulate as sodium nitrite. Outside the body they greatly diminish oxidation, and the same takes place in the blood. After the inhalation of a considerable amount (more than is usually given to a man) the arterial and venous blood both become a uniform chocolate colour. This is due to the formation of methæmoglobin and another body, probably nitric oxide hæmoglobin. The hæmoglobin can no longer absorb oxygen, and hence its oxidizing power is abolished. By this action on the blood nitrites may kill; therefore the treatment for poisoning by them is inhalation of oxygen, that more may be dissolved in

the plasma. In some of the lower animals they kill by acting as a direct poison to animal tissues.

THERAPEUTICS.

Heart and Blood-vessels.—Brunton in 1867 observed that in a case of angina pectoris the peripheral vessels were strongly contracted during an attack of pain. This induced him to make the patient inhale amyl nitrite, and it was found that the vessels dilated and the pain passed off. Inhalation of amyl nitrite is now used for all sorts of cardiac pain, especially when it comes on in paroxysms. Generally the drug affords relief in a minute or so after inhalation, but by no means always. We do not sufficiently understand the pathology of angina pectoris to know how it acts. It may be by dilating the peripheral vessels, but against that view is the fact that they are not always contracted during attacks of angina pectoris; and amyl nitrite may relieve patients in whom the vessels are not contracted. The attacks of pain common in thoracic aneurysm may be relieved by it. It is successfully used to avert the dangerous pallor sometimes seen during the administration of chloroform, and may be inhaled for other forms of syncope. The peculiar hot flushes experienced by some women during the menopause are benefited by inhalation of it. It is said to be useful, by lowering the blood pressure, in hæmoptysis and other varieties of severe hæmorrhage.

Nervous system.—If it is inhaled when the aura is felt, an epileptic fit may sometimes be prevented, and it has also been found useful during the status epilepticus. Because in migraine the vessels of the head are contracted, it has been used, and sometimes successfully, for this complaint. Its depressing action

on the cord has suggested its employment in tetanus and strychnine poisoning.

Occasionally the inhalation of amyl nitrite relieves an attack of asthma. It has been given in whooping-cough, sea-sickness, and cholera, but without much good effect.

NITROGLYCERIN.

Trinitroglycerin. $C_3H_5[(NO_2)O]_3$. (Not official.)

Synonyms.—Trinitrin, Glonoin oil, Nobel's blasting oil.

SOURCE. Glycerin is dropped into a mixture of sulphuric and nitric acids kept cool by ice.

CHARACTERS.—A colourless oily liquid. Sp. gr. 1·6, slightly soluble in water, easily in fats, oil, alcohol, ether. Highly explosive. Mixed with silica forms dynamite.

Dose, $\frac{1}{200}$ to $\frac{1}{50}$ gr.—0·3 to 1·5 milligrms.—never used undiluted.

Preparations (Official).

1. Liquor Trinitrini. — Nitroglycerin, 1; alcohol (90 per cent.), 100. *Strength.*—1 per cent. Sp. gr. 0·840.

Dose, $\frac{1}{2}$ to 2 m.—3 to 12 centimils.

2. Tabellæ Trinitrini.—Nitroglycerin, 0·5 milligrm.; chocolate, 0·3 grm. Chocolate is used, as with it there is no risk of explosion. Each contains $\frac{1}{130}$ gr. of nitroglycerin.

Dose, 1 or 2 tablets.

ACTION AND THERAPEUTICS.

Its action is the same as that of amyl nitrite, except that in many animals, and probably in man, large doses do not form methæmoglobin in the blood; the effects of nitroglycerin are more persistent, and as it is only suitable for administration by the mouth, they are slower in their onset. It is frequently taken by persons liable to cardiac pain, with the object of warding off the attack, and often such persons require and bear large doses. Small doses are often

used to lower the arterial tension in arterio-sclerosis and chronic interstitial nephritis. Occasionally it does good in asthma. It is really a nitrate of glycerin, but physiologically it belongs to the class of nitrites, for directly it gets into the blood, sodium nitrite is formed.

SODII NITRIS.

Sodium Nitrite. $NaNO_2$.

SOURCE.—Made by fusing sodium nitrate with lead, which becomes an oxide, taking oxygen from the nitrate.

CHARACTERS.—A white crystalline deliquescent powder, very soluble in water.

Dose, ½ to 2 gr.—3 to 12 centigrms.

LIQUOR ETHYL NITRITIS.

Solution of Ethyl Nitrite.

A mixture of 95 parts by volume of absolute alcohol, with 5 parts by volume of glycerin, containing, when freshly made, 3 per cent. by weight, and even when long kept not less than 2½ per cent. of ethyl nitrite.

SOURCE.—Obtained by the interaction of alcohol (90 per cent.), sodium nitrite, and diluted sulphuric acid at a low temperature.

CHARACTERS AND TESTS.—A limpid, almost colourless liquid with characteristic apple-like odour and taste. Highly inflammable. Sp. gr. 0·823 to 0·826. Should be stored in small bottles.

Dose, 15 to 60 m.—1 to 4 mils.

ACTION AND THERAPEUTICS.

The action of sodium nitrite and ethyl nitrite is the same as that of amyl nitrite and other nitrites. They are suitable for the same cases as nitroglycerin, as they are slower and gentler in their action than amyl nitrite. Sodium nitrite has the same action on the blood as amyl nitrite.

ERYTHROL NITRAS. (Not official.)

Erythrol Nitrate. *Synonym.*—Erythrol tetranitrate.

CHARACTERS.—Hard colourless acicular crystals. *Solubility.*—Not in water; 1 in 60 of absolute alcohol.

Dose, ½ to 1 gr.—3 to 6 centigrms.

Erythrol nitrate, from which nitrites are formed in the body, has the same action as nitrites. It is less powerful than nitrite of amyl and nitro-glycerin. It is best given in chocolate tablets. Its action is slow.

CLASS IV.—**Hypnotics.**

Chloral Hydras, Butyl-chloral Hydras, Chloralamide, Glucochloral, Chlorbutol, Paraldehydum, Sulphonal, Methylsulphonal, Barbitonum and its derivatives.

CHLORAL HYDRAS.

Chloral Hydrate, $C_2Cl_3H_3O_2$.

SOURCE.—Ethylic alcohol is saturated with dry chlorine, and thus chloral C_2Cl_3HO is formed. It is purified and water is added to form a hydrate.

CHARACTERS.—Colourless monoclinic plates of a pungent, peculiar odour and a bitter taste. Easily melted by gentle heat. *Solubility.*—Freely in distilled water, alcohol (90 per cent.), and ether. Forms a fluid when rubbed up with an equal weight of camphor.

INCOMPATIBLES.—All alkalies decompose it.

IMPURITIES.—Hydrochloric acid and oily impurities.

Dose, 5 to 20 gr.—3 to 12 decigrms.

Preparation.

Syrupus Chloral. Choral hydrate, 1; distilled water, 1; syrup to produce 5. *Strength.*—10 millilitres contain 2 grms. of chloral hydrate; 1 fl. dr. contains 10·9 grs.

Dose, ½ to 2 fl. dr.—2 to 8 mils.

Action.

External.—It is a powerful antiseptic. Locally applied it is irritant, causing vesication.

Internal.—*Alimentary canal.*—Unless diluted, chloral hydrate is a gastric irritant; large doses therefore may give rise to vomiting and purging.

Blood.—It is readily absorbed, and circulates in the blood unchanged. It was formerly thought that as alkalies convert it into chloroform and formic acid, this change would take place in the blood, and consequently Liebreich suggested its use as an hypnotic. It is now known that this view is wrong, for no chloroform can be found in the blood of chloralized animals, nor in the breath, nor in the urine unless that fluid is alkaline, in which case chloral hydrate is decomposed by the alkali in the urine.

Circulation. — Therapeutic doses hardly affect this, but large ones depress the heart considerably, owing to a local effect on the organ itself; probably both the muscular substance and the nerves contained in it are affected. The pulse, which may at first be slightly quickened, soon becomes slow, feeble, and irregular, and the heart finally stops in diastole. The vaso-motor centre is depressed, and consequently the vessels dilate. As a result of these actions on the heart and the vessels the blood-pressure falls.

Respiration.—After large doses the respirations become slow and full, and after toxic doses they become irregular and shallow before finally ceasing. This is due to the action of chloral hydrate on the respiratory centre.

Temperature.—Large doses cause a fall by diminishing the production and increasing the loss of heat.

Brain.—Chloral hydrate is a powerful hypnotic, acting directly on the brain. The stage of excita-

tion, if it exists, is very short. Soon after taking a moderate dose the patient is overcome by sleep, which lasts several hours, and is indistinguishable from natural sleep. On waking there is neither confusion nor headache, and he feels refreshed. Large doses produce coma. The pupil is always contracted.

Spinal cord.—At first the anterior cornua may be slightly stimulated, but soon they are depressed, and there is consequently paralysis and loss of reflex excitability. The motor nerves and the muscles are not affected, nor are the sensory nerves unless the dose is very large, when there may be anæsthesia.

Metabolism.—Prolonged large doses lead to fatty degeneration of the tissues and to an increase of nitrogen, phosphorus, and sulphur in the urine, indicating an excessive breaking down of protein tissues. The urine reduces Fehling's solution; this is due to the presence of urochloralic acid, not to sugar, as was formerly thought.

It will be observed that chloral hydrate is a powerful general depressant, chiefly of the cerebrum, but also of the respiratory centre, the vaso-motor centre, the anterior cornua, the production of heat, and the heart. It is only because it depresses the cerebrum much earlier than any other part of the body that we can use it as an hypnotic. Chloral hydrate is often called chloral, but this is an oily liquid.

THERAPEUTICS.

External.—The compound with camphor has been employed as a local anodyne for neuralgia, and may be applied to aching teeth.

Internal.—Chloral hydrate is largely used for its hypnotic effect. Its great advantages over many other hypnotics are that doses sufficient to produce a deep sleep are not large enough to cause gastro-intestinal irritation, cardiac and respiratory depression,

and the other harmful effects. Chloral hydrate is certain in its action; it quickly produces sleep; and there are no bad after-effects. Children take it well.

It is especially useful in simple insomnia from overwork or worry. Its disadvantages are that it does not relieve pain at all, and it should therefore not be used for insomnia due to this cause; and that, as it depresses the heart and respiration, it must be given carefully in diseases of the heart and lungs, and also when the stomach or intestines are diseased, as it may irritate these structures. In febrile insomnia it is very valuable in the early stages, but must be given cautiously later when there is any danger of cardiac weakness. It does not relieve the distress and cough of diseases of the heart and lungs. It has been used as a cerebral depressant in delirium tremens, puerperal convulsions, and mania, but very large doses are required, and consequently the results must be watched with great care. Amylene chloral (Dormiol) may be given (dose up to 30 ♏, 20 decimils).

From its action on the spinal cord chloral hydrate has been used, but with little success, in tetanus, whooping-cough, incontinence of urine, and strychnine poisoning.

Hypnal (dose, up to 2 gr., 30 grm., in a cachet), a compound of chloral hydrate and antipyrin, has been used to produce sleep when pain is present.

Toxicology.

Acute Poisoning.—As will be inferred from the action of chloral hydrate, the symptoms of poisoning by it are deep coma; a weak, feeble, irregular, slow pulse, which may become quick before death; diminished frequency of respiration and consequent lividity; and abolition of reflex movements. The surface of the skin is cold, and the temperature is subnormal.

Treatment.—Give emetics (see p. 145) or wash out the stomach. Keep up the temperature by hot bottles, hot blankets, friction, and massage. Prevent sleep by the injection

of hot strong coffee into the rectum, shouting at the patient, hitting him, flapping with wet towels, bathing, &c. Give a subcutaneous injection of strychnine, because of its stimulant action on the anterior cornua. Use inhalations of amyl nitrite to stimulate the heart, and artificial respiration if necessary.

Chronic poisoning.—The taking of chloral hydrate is a vice to which many persons are addicted. A craving for it is soon established. The chief symptoms of chronic chloral poisoning are gastro-intestinal irritation, a great liability to erythematous eruptions, dyspnœa dependent upon the cardiac and respiratory depression, and general weakness. There may be disturbance of the mental equilibrium, and persons have been known to become permanently weak-minded. A slightly larger dose than usual may be quickly fatal.

BUTYL-CHLORAL HYDRAS.

Butyl-chloral Hydrate, Trichlorbutylidene Glycol.
$C_4H_7Cl_3O_2$.

Synonym.—Croton chloral hydrate. (This is a misnomer.)

Source.—Dry chlorine gas is passed through aldehyde. Butyl-chloral is formed. It is separated by fractional distillation, and water is added.

Characters.—Pearly white crystalline scales, with a nauseous taste and a pungent odour like chloral hydrate. *Solubility.*—1 in 50 of water; freely in spirit and glycerin.

Incompatibles.—All alkalies.

Dose, 5 to 20 gr.—3 to 12 decigrms.

Action and Therapeutics.

The action of this drug is exactly similar to that of chloral hydrate, but it is less certain in its effects. It is said to be less depressant to the heart, and to have a specific action in relieving neuralgia of the fifth nerve, but both statements are doubtful.

CHLORAL FORMAMIDE.

Chloral Formamidum.—$C_3H_4Cl_3NO_2$. *Synonym.* —Chloralamide.

Source.—Formed by the direct combination of formamide with anhydrous chloral. Should be preserved in amber-coloured bottles.

CHARACTERS.—Shining colourless crystals. Taste slightly bitter. *Solubility.*—Slowly in about 1 in 20 of water, 1 in 2 of alcohol (90 per cent.), and in weak acid solutions. Should not be heated over 140°F., or mixed with alkalies, for in either case it decomposes.

Dose, 15 to 45 gr.—1 to 3 grms.

ACTION AND THERAPEUTICS.

Chloralamide is an excellent hypnotic, producing calm refreshing sleep without any bad after-effects. It has little or no cardiac, vaso-motor, or respiratory depressant action. In the blood it is decomposed into chloral and formamide, and it may be that the latter prevents the depressant action of the chloral. Frequent use does not necessitate an increased dose, nor, as far as we know, is any chloralamide habit contracted. It does not relieve pain, but is equally serviceable for all varieties of insomnia unless due to pain. If possible it should not be given as a powder, for it is then so very slowly absorbed that probably some of it is decomposed in the intestines or stomach; occasionally, when powdered chloralamide has been administered in the evening, the patient has not slept during the night, but has slept all the next day, because the drug has been so slowly absorbed. The best way to give it is to dissolve it in a little alcohol. The patient may be told to dissolve 20 or more grains in sufficient brandy, to add water not above 130°F. (55°C.), and drink it before going to bed. It will require stirring for some time. Some specimens are very insoluble, and must be suspended. It is said that 10 minims (6 decimils) of aromatic sulphuric acid added to 1 fl. oz. (30 mils) of water will dissolve 30 gr. (2 grms.) of chloralamide, but this is not always true. The Mistura Chloralamidi Co. (B. P. C.)—dose, ½ to 1 fl. oz. (15 to 30 mils), which contains potassium bromide, is often useful.

Chloralamide acts if given as an enema. Fifteen grains (1 grm.) of each of potassium bromide and chloralamide, flavoured with tincture of orange and chloroform water, is strongly recommended for insomnia and for sea-sickness. This mixture resembles a proprietary preparation called chlorobrom.

Glucochloral. (Not official.)

Synonyms.—Chloralose, Anhydro-gluco-chloral.

CHARACTERS.—Small white bitter crystals, slightly soluble in water.

Dose, 3 to 10 gr.—2 to 6 decigrms.—in a cachet.

ACTION AND THERAPEUTICS.

This drug is soporific, having a similar action to chloral, except that, in large doses, it produces increased reflexes and convulsions; but it is less depressant, and may be given in cases of heart disease. It is also useful in asylum practice.

Chlorbutol. (Not official.)

Synonyms.—Chlor-butyl-alcohol. Chloretone.

CHARACTERS.—White needles, sparingly soluble in water.

Dose, 5 to 20 gr.—3 to 12 decigrms.—in a cachet.

ACTION AND THERAPEUTICS.

It is a local anæsthetic, and 5 grains may be used, made into a suppository, for piles, and 1 part with 10 of zinc oxide forms a dusting powder for painful sores, as burns. Internally it is a good hypnotic, is useful for whooping-cough, and has been used for sea-sickness.

PARALDEHYDUM.

Paraldehyde. $C_6H_{12}O_3$.

SOURCE.—A product of the polymerization of acetaldehyde.

CHARACTERS.—A colourless liquid of ethereal odour and burning taste. Sp. gr. 0·998 to 1·000. *Solubility.*—1 in 10 of water; freely in alcohol and ether. It should be kept preserved from light and air.

Dose, ½ to 2 fl. dr.—2 to 8 mils—in capsules or a mixture (*see* p. 326).

Action.

External.—It is antiseptic.

Internal.—Large doses increase the flow of urine and somewhat strengthen the heart, but they do not affect the gastro-intestinal tract or respiration; enormous doses weaken the heart, and kill by paralysis of the respiratory centre.

Nervous system.—It is a powerful hypnotic, without any unpleasant after-effects, acting as a direct cerebral depressant. It operates quickly, and the sleep, which lasts several hours, is quiet, refreshing, and dreamless. Paraldehyde in toxic doses paralyses the anterior cornua of the spinal cord. It does not affect nerves or muscles.

Therapeutics.

It is given solely as an hypnotic in the same class of cases as chloral, and as it does not act on the heart it may also be used for patients suffering from cardiac disease. It has been used largely in asylums to produce quiet in mania and sleep in melancholia. It may produce an erythematous rash. Unless given in capsules the great objection to its use is its nasty taste, which is best covered by syrup and tincture of orange peel with at least two fluid ounces of water to ensure a usual dose being dissolved. It gives its unpleasant odour to the breath, which lasts many hours. Its nasty taste usually prevents the formation of a paraldehyde habit, but occasionally this is contracted and the symptoms exactly resemble those of delirium tremens.

SULPHONAL.

Dimethyl-methane-diethylsulphone.

$C_7H_{16}S_2O_4$.

Source.—It is a product of the oxidation of mercaptol.

Characters.—Colourless prismatic crystals, inodorous, almost tasteless. *Solubility.*—1 in 450 of cold, 1 in 15 of

boiling water; 1 in 80 of alcohol (90 per cent.) or ether; 1 in 3 of chloroform.

Dose, 10 to 30 gr.—6 to 20 decigrms.—in cachets or suspended in mucilage, or in flavoured boiling water, drunk as soon as cool enough.

Action and Therapeutics.

Sulphonal is a direct cerebral depressant and hypnotic. It does not depress the heart. The drug is given for the same class of cases as chloral hydrate, but as it is so insoluble it is absorbed with difficulty and slowly; hence it takes two or more hours to act, its action may be prolonged into the next day, and it is unsuitable for frequent use. It produces its effect most rapidly if the fluid in which it is suspended is hot, but as they are so much more convenient it is usually given in cachets an hour and a half before bedtime. Sulphonal rarely leads to a "sulphonal habit" or to any disagreeable after-effects. The symptoms of a sulphonal habit are general lethargy, mental, moral and muscular weakness, loss of nutrition, and dyspepsia. It has been known to produce eruptions on the skin and hæmatoporphyrin in the urine. Enormous single doses produce, in addition to these symptoms, prolonged sleep, lasting many days, paralysis of sphincters, anuria, a fall of temperature, and depression of respiration.

METHYLSULPHONAL.

Methylsulphonal.—Diethyl-sulphone-methyl-ethyl-methane, $C_8H_{18}S_2O_4$. *Synonym.*—Trional.

Source.—It is an oxidation product resulting from the condensation of ethyl-methyl-ketone with ethyl-mercaptan.

Characters.—A white crystalline powder; slightly bitter. Almost insoluble in water and poorly in alcohol.

Dose, 10 to 20 gr.—6 to 12 decigrms. Best given in cachet.

Action and Therapeutics.

It is used for the same purposes as sulphonal, and like it may produce hæmatoporphyrinuria. As a rule it acts more quickly than sulphonal. It is rare for it to lead to the formation of a habit or to induce disagreeable after-effects, but its toxic symptoms are the same as those of sulphonal.

BARBITONUM.

Barbitone. — $C_8H_{12}N_2O_3$. *Synonyms.* — Diethylbarbituric acid; malonurea; diethyl-malonyl-urea; veronal; hypnogen.

Source.—May be obtained by the interaction of the diethylester of malonic acid, and carbamide.

Characters.—A white crystalline powder. Inodorous. Taste faintly bitter. Slightly soluble in cold water, more in *hot and in alcohol, freely in aqueous alkaline solutions.*

Dose, 5 to 10 gr.—3 to 6 decigrms. Best in cachets or tablets.

Action and Therapeutics.

An hypnotic, inducing refreshing sleep almost always without evil effects, but occasionally it causes a severe erythematous rash, and rarely an ordinary dose has produced dangerous and even fatal symptoms. It depresses the central nervous system but not the heart, and patients do not acquire the habit of taking it. Large doses may be given to insane or delirious patients. As with all insoluble hypnotics, sleep may be deferred till some time after giving the drug. **Medinal** (sodium diethylbarbituric acid), dose 5 to 10 grains (3 to 6 decigrms.) dissolved in water, **Luminal** (phenylethylbarbituric acid) same dose, **Bromural** or **Uvaleral** (mono-bromisovalerianylurea) same dose, and **Uradal**, also known as **Adalin** (bromodiethyl-acetyl-urea), dose 5 to 15 grains (3 to 10 decigrms.) in a cachet, are given as hypnotics. Often they are very useful.

Class V.—**Drugs which have an Antipyretic or Analgesic Action.**

Acetanilidum, Phenazonum, Phenacetinum, Salipyrin, Phenocitrin, Amidopyrin, Exalgin, Methylene Blue, Orthoform.

ACETANILIDUM.

Acetanilide. C_8H_9NO.

Synonyms.—Antifebrin, Phenyl-acetamide.

Source.—Glacial acetic acid and aniline are heated together. Acetanilide is distilled over and purified by crystallization.

Characters.—Colourless scaly crystals of a pungent taste. *Solubility.*—1 in 200 of cold water, 1 in 18 of boiling; 1 in 4 of alcohol (90 per cent.); freely in ether and chloroform.

Dose, 2 to 5 gr.—12 to 30 centigrms.—in cachets or suspended.

PHENAZONUM.

Phenazone. $C_{11}H_{12}N_2O$. *Synonyms.*—Antipyrin, Phenyl-dimethyl-isopyrazolone.

Source.—Aceto-acetic ether is acted on by phenyl-hydrazine, when phenyl-methyl-isopyrazolone, ethyl alcohol, and water are formed. The monomethyl compound is heated with methyl iodide and methyl alcohol.

Characters.—Colourless, odourless, scaly bitter crystals, freely soluble in water, alcohol, and chloroform.

Incompatibles.—It is incompatible with so many substances that it should be prescribed alone.

Dose, 5 to 15 gr.—3 to 10 decigrms.

PHENACETINUM.

Phenacetin. $C_{10}H_{13}NO_2$. *Synonym.*—Para-acetophenetidin.

Source.—Glacial acetic acid is made to act upon paraphenetidin.

Characters.—Colourless, tasteless, scaly crystals, very sparingly (1 in 1700) soluble in water. Soluble in 20 parts of alcohol (90 per cent.); insoluble in glycerin.

Dose, 5 to 15 gr.—3 to 10 decigrms.—in cachets, capsules or suspended.

Actions of Acetanilide, Phenazone, and Phenacetin.

None of these substances has any action externally or on the gastro-intestinal tract. Acetanilide and phenazone are local hæmostatics, as they contract blood-vessels when applied to them. Acetanilide and phenacetin are in the body converted into para-amido-phenol and act as such. The change takes place the more rapidly with acetanilide and hence that is the more powerful and dangerous of the two.

Blood.—With ordinary doses of these drugs this fluid is unaffected, but in large doses the colour is changed from the formation of methæmoglobin. The passage of this in the urine discolours it. Acetanilide causes the red corpuscles to break up, and arrests the movements of the white. We do not know for certain whether the other two substances can produce this result.

Heart.—All three, in large doses, depress the heart, probably owing to a paralysing action on the cardiac muscle. This cardiac depression is much less marked with phenacetin than the other two, and is perhaps less with phenazone than acetanilide. Some persons, especially weakly women, are particularly susceptible, and the dangerous symptoms described under Toxicology may be easily produced in them.

Vessels.—Acetanilide and phenazone contract the smaller vessels from direct action on their muscular coat. The blood-pressure therefore rises at first, but later it falls from the cardiac depression.

Respiration.—This is not affected by ordinary doses. After toxic doses the force of the respiratory act progressively diminishes.

Kidneys.—Large doses of any of these drugs cause the urine to be dark from the passage of altered blood. Phenazone is quickly excreted as such combined with sulphuric acid in the urine. The other two often lead to the appearance of glycuronic acid in the urine.

Skin.—Any of these three drugs may produce an erythematous rash which is usually measly or urticarial, and they are occasionally mild diaphoretics.

Temperature.—These three substances are all powerful antipyretics. They have a very slight action on the temperature of health, but they reduce it very markedly when it is raised from any cause. They were all introduced into medicine for this property. We have already seen (*see* p. 72) how numerous are the ways in which antipyretics may act. *The fall of temperature produced by these drugs is* not due to any action on the blood or the circulation, and it is too marked to be entirely owing to their slight diaphoretic action. If a fevered patient has a temperature, say 5° F. above normal, it is clear that the heat production and loss are so balanced as to maintain this temperature, just as they are normally adjusted to maintain it at 98·4°. The adjusting mechanism—called the thermotoxic—is believed to be in the cerebrum and antipyretics are supposed to act chiefly on the central thermotoxic mechanism so that the temperature of the fevered patient is adjusted for a lower level. They also increase heat dissipation and some think the production is decreased.

Nervous system.—These three drugs are powerful analgesics. Acetanilide and phenazone in large doses are said to produce first convulsions, then coma and paralysis of motor nerves and muscles; but all these statements require further experiments.

Therapeutics of Acetanilide, Phenazone, and Phenacetin.

External.—Acetanilide is occasionally employed as a dusting powder, or as an ointment (20 gr., 12 decigrms., to 1 oz., 32 grms.), for chronic ulcers and eczema.

Internal. — *Pyrexia.* — Originally these drugs were introduced into medicine on account of the property they have of reducing pyrexia. The opinion now is, however, that if the temperature is not dangerously high no attempt should be made to reduce it, for probably the raised temperature is an endeavour on the part of the body to defend itself against the micro-organisms which are the cause of the particular fever from which the patient is suffering; in other words, the pyrexia is a "defensive mechanism." Further, these drugs are all cardiac depressants and therefore unsuitable for patients suffering from fever, and this last consideration makes many physicians prefer to use cold water rather than these drugs when the temperature is so high that it is considered that it, in itself, is dangerous to life. Should it, however, for any reason be decided to give one of these drugs as an antipyretic, phenacetin has the great advantage of depressing the heart very little, and rarely producing the alarming toxic effects described below. It is, however, very insoluble, and slower and less powerful in its action than the other two, but the effect lasts longer. In order to gain a rapid effect, those who use these drugs commonly give either phenazone or acetanilide. Phenazone has the advantage of being soluble, and the balance of evidence is that toxic symptoms are more common after acetanilide, which, too, does not keep the temperature down quite so long as phenazone. Both take about two hours to reduce the pyrexia to its minimum, the last named being rather

the more rapid of the two. Phenazone may be given subcutaneously, but this is not advisable, as sores may be produced. Either may be given *per rectum*.

Analgesic action.—All these drugs have the property of relieving pain. It is least marked with acetanilide, most with phenazone; but as phenacetin possesses it very strongly it is perhaps on the whole to be preferred as an analgesic, for toxic results after it are very rare. These drugs, especially phenazone, are largely used to relieve the pains of neuralgia, sciatica, dysmenorrhœa, locomotor ataxy, migraine, and various headaches. The dose of phenacetin for this purpose is 5 grains (3 decigrms.) every hour for three or four hours; this generally gives relief. Doses of 10 grains (6 decigrms.) of phenazone may be used for the same purpose. Useful preparations are Phenacetinum cum Caffeina Effervescens (B. P. C.), dose 60 to 120 gr. (4 to 8 grms.), and Pulvis Acetanilidi Compositus (B. P. C.), dose 3 to 5 gr. (1 to 3 decigrms.). Antikamnia, a proprietary drug, contains acetanilide 70 per cent., caffeine 10 per cent., and sodium bicarbonate 20 per cent. Antinervin contains acetanilide, sodium salicylate, and potassium bromide.

Toxicology.

All these drugs occasionally produce in man collapse, cyanosis, very slow respiration, a feeble and irregular pulse, vomiting, profuse sweating, and profound prostration. Many deaths have been caused by them. It has been stated that during one epidemic of influenza in Vienna seventeen persons were killed by phenazone. Acetanilide is most likely, and phenacetin least likely, to be accompanied by symptoms of poisoning. *Any of these drugs* may produce a rash, most often like measles or scarlet fever, but sometimes like pemphigus.

Treatment.—Stimulation by alcohol and ether subcutaneously and by the mouth. Strychnine subcutaneously to stimulate the heart. Oxygen inhalations. Warmth to the feet and body.

Salipyrin (Not official), containing 42·3 per cent. of phenazone and 57·7 per cent. of salicylic acid, has been used chiefly as an analgesic for chronic rheumatism and sciatica.

Dose, 10 to 15 gr.—6 to 10 decigrms.—in a cachet, or dissolved in alcohol.

Phenocitrin (Not official)—*Synonym*, Citrophen—a combination of citric acid and paraphenetidin (**Dose, 3 to 8 gr. (2 to 5 decigrms.)** in water), has been used to relieve headache.

Amidopyrin (Not official)—*Synonym*, Pyramidon—an amido- derivative of antipyrin (**Dose, 5 to 10 gr.** (3 to 6.decigrms.) in a cachet), has been much used for headaches and neuralgia.

Exalgin.—(Not official.)

Synonym.—Methylacetanilide. $C_6H_5N(CH_3)CH_3CO$.

CHARACTERS.—Colourless acicular or tabular crystals, with a slight saline taste. *Solubility.*—1 in 60 of water; freely in alcohol.

Dose, ½ to 3 gr.—3 to 20 centigrms.

Exalgin is a powerful analgesic, and has been given with success for neuralgia. Often it relieves when many other drugs have failed. Medicinal doses rarely cause depression, but very large quantities may be dangerous, breaking up the blood like acetanilide. It is best dissolved in Tinctura Aurantii, and flavoured with Syrupus Aurantii Floris, but may be made into a pill with syrup of glucose.

Methylene Blue. (Not official.)

Tetramethylthionine hydrochloride. An aniline derivative.

CHARACTERS.—Dull, dark green crystals forming an intensely blue solution in water. As commercial methylene blue contains zinc chloride, it must be ordered medically pure.

Dose, 1 to 4 gr.—6 to 25 centigrms.

It has been used as an analgesic in neuralgia, migraine, sciatica, and rheumatism. Some authors recommend it strongly for malaria. It colours both urine and fæces a brilliant blue. Occasionally it causes cystitis.

Orthoform. (Not official.)

The methylester of meta-amidoparaoxybenzoic acid.

CHARACTERS.—A white crystalline powder with neither taste nor smell, and very slightly soluble in water.

It is non-poisonous, and has no action on healthy skin and mucous membranes, but applied to abraded surfaces, either as a powder or ointment (10 to 20 per cent. with lanolin), it is a powerful local anæsthetic, and is of great use to relieve the pain of cancer, ulcers, and burns. It is often successfully applied to the larynx, and in doses of 1 to 3 gr. (6 to 20 centigrms.) it relieves the pain of cancer of the stomach.

CLASS VI.—**Antiseptics.**

Carbolic Acid, Picric Acid, Resorcin, Creosote, Guaiacol, Iodoform, Naphthol, Cresol, Creolin, Cyllin, Oxoquin, Quinophan, Lysol, Izal, Kerol, Ialine, Formaldehyde, and Hexamine.

ACIDUM CARBOLICUM.

Carbolic Acid. Phenol, or Phenyl alcohol. C_6H_6O.

SOURCE.—From coal-tar oil by fractional distillation, and purification.

CHARACTERS. — Colourless deliquescent crystals of a peculiar odour. Taste sweetish, pungent. Treated with about 6 per cent. of water, they become fluid; they are very hygroscopic, and hence soon become semi-fluid on exposure to air. Often reddish from the impurities aurin and rosolic acid, which form a red compound by the absorption of carbonic acid and oxygen. Melts at 40°C. to an oily liquid. Does not redden litmus paper, coagulates albumen. *Solubility.*—1 in 14 of water; freely in alcohol, fats, and oils.

It is contained in Injectio Ergotæ Hypodermica.

Dose, 1 to 3 gr.—6 to 20 centigrms.—as a pill. The pill mass is best made thus: Acidum Carbolicum, 60 gr.; hard paraffin, 12 gr.; wheaten flour, 45 gr.; glucanth, 3 gr.

Preparations.

1. Acidum Carbolicum Liquefactum.—Phenol, 100; water, to produce 115.

Dose, 1 to 3 m.—6 to 18 centimils.

2. Glycerinum Acidi Carbolici.—Phenol, 1; glycerin, 5.

3. Suppositoria Acidi Carbolici.—1 gr. (0·067 grms.) in each. Made with white beeswax and oil of theobroma.

4. Trochiscus Acidi Carbolici.—Phenol, 15; refined sugar, 500; gum acacia, 45; tragacanth, 15; lemon juice, 45. A simple basis.

Each lozenge contains 0·03 grm. of Phenol or approximately $\frac{1}{2}$ gr. It is one-half the strength of the corresponding preparation B. P. 1898.

5. Unguentum Acidi Carbolici.—Phenol, 3; white paraffin ointment, 97.

Action.

External.—Carbolic acid, being a protoplasmic poison, is a powerful **antizymotic**, rapidly destroying organized ferments, both animal and vegetable. Consequently it destroys those of septic diseases, hence it is **antiseptic.** It thus prevents the formation of the products of the decompositions which are set up by these organisms. For this reason it is **disinfectant**, and as these products of decomposition are generally foul-smelling, it is **deodorant.** It acts rapidly on micro-organisms as it is easily soluble in proteins and lipoids. It does not act so readily on unorganized ferments (enzymes), such as pepsin and ptyalin, but in large doses it likewise destroys their activity. Carbolic acid has the great practical advantage that its efficacy is not much reduced by the presence of organic matter. The solution in oil has no antiseptic properties. The power of carbolic acid to destroy low organisms makes it an efficient **parasiticide** against certain vegetable parasites infesting the skin.

When applied to the skin in weak or moderately strong solutions, it produces **local anæsthesia** with a feeling of numbness, which lasts some hours. If concentrated it acts as an **irritant** and **caustic**, causing a burning pain, and in a few minutes a

white spot appears, which becomes red when the acid is removed. If the application is prolonged a white eschar or slough results. There is no vesication.

Internal.—*Gastro-intestinal tract.*—If concentrated, carbolic acid produces the same effect on the mouth as on the skin, and is a powerful gastro-intestinal irritant (*see* Toxicology). In the stomach it is converted into a sulphocarbolate, and unless poisonous doses be given, it is so diluted by the gastric contents that it loses its antizymotic power.

Blood.—It is not known in what form carbolic acid circulates.

Circulation.—Medicinal doses have no effect. Large doses paralyse the vaso-motor centre in the medulla, and the blood-pressure falls. It is not until very large doses have been given that the heart is affected, and then its activity is depressed.

Respiration.—Small doses have no influence on respiration, but large ones accelerate it, probably from stimulation of the vagi. Ultimately respiration is paralysed, and death results.

Temperature.—This is unaffected by small doses of carbolic acid, but large doses cause it to fall, because they diminish the production of heat and increase its dissipation.

Nervous system.—Carbolic acid is a cerebral depressant in large doses, for coma is produced by them; they first stimulate the anterior cornua, producing convulsions, but subsequently depress them, causing paralysis.

Urine.—Much interest attaches to this, for even after moderate doses of carbolic acid, or absorption from surgical dressings, the urine may become dark, especially on being kept exposed to air. This is not due to blood, as was once thought, for Sir Thomas Stevenson has shown that there is no increase of iron in the urine. After taking carbolic acid, salts of phenyl sulphuric acid and glycuronic acid,

pyrocatechin and hydroquinone appear in the urine. The last two are oxidation products of carbolic acid, which on further oxidation produce dark-coloured substances, which are the cause of the colour of the urine. The presence in the urine of these results of carbolic acid is recognized by distilling them over from it after acidifying with sulphuric acid. The distillate gives a blue colour with neutral ferric chloride, a white crystalline precipitate of tribromophenol with bromine water, and a red colour on heating with Millon's reagent. Some carbolic acid escapes in the other excretions; some is burnt up in the body. When very large doses are given, carbolic acid itself may appear in the urine in the free state.

Therapeutics.

External.—Carbolic acid is largely used as a deodorant and disinfectant for drains, bed-pans (for which the cheap crude acid may be employed), soiled linen, surgical instruments, the surgeon's hands, &c. Carbolic lotion (1 in 40) is used to wash wounds to keep them antiseptic, and carbolized gauze (which is unbleached cotton gauze medicated with half its weight of a mixture of carbolic acid 1, resin 4, paraffin 4) is employed as a dressing for the same purpose. Carbolized gauze and carbolized lint are also prepared. A spray of a solution of carbolic acid was formerly much used to keep the air round the wound antiseptic during an operation, but it is now discarded as unnecessary.

Glycerin of carbolic acid is used to destroy the fungus of tinea tonsurans or tinea versicolor; for the latter it should be diluted.

Because of its anæsthetic effect a strong solution (1 in 20) will relieve itching from any cause. Carbolized vapour has been inhaled in phthisis, but by the time it reaches the lungs it is far too dilute to have any action on the tubercle bacilli.

Internal.—*Mouth.*—The glycerinum, if diluted, may be applied as a stimulant to the mouth in aphthous stomatitis, or when any indolent ulceration is present. A gargle (15 ♏, 1 mil, of Glycerinum Acidi Carbolici to 1 fl. oz., 30 mils, of water) is an excellent preparation. The glycerinum has been used for diphtheria, but probably it does no good, except that being a local anæsthetic it soothes pain, for it must be remembered that the glycerin greatly lessens the antiseptic power of the carbolic acid. A piece of cotton wool soaked in strong carbolic acid will relieve pain if placed in a decayed tooth, but care must be taken to prevent it from coming in contact with the soft parts, by putting another piece of dry cotton wool over it.

Stomach.—Carbolic acid has been given to relieve flatulence, because it was thought that it would prevent decomposition in the stomach; but it is powerless to do this, owing to the degree to which the gastric contents dilute it. Some state that it checks vomiting and helps to cure dyspepsia, but it is not a remedy which is universally regarded as useful for these purposes. It may, however, be tried in obstinate cases, and it will sometimes be found to be a good carminative. Carbolic acid has been given internally as an antiseptic in phthisis, but it does no good, as none reaches the lungs. It has been unsuccessfully tried in typhoid fever.

Dimol.—(Not official.) A complex phenol. It is stated that neither it nor any derivative of it is absorbed from the alimentary tract, therefore it is used as an intestinal disinfectant. Generally 2 to 4 "Pulverettes," each containing gr. i, are taken after each meal.

Toxicology.

If carbolic acid is at all concentrated, immediately on swallowing it there is an intense burning sensation in the

mouth, gullet, and stomach, and white eschars form in the mouth. The patient is collapsed, his skin is cold and clammy. The breathing becomes more and more feeble and shallow, and finally stops. The urine is darkish green. Reflex movements are abolished, and ultimately he becomes insensible and comatose. *Post mortem.*—There are white, hard sloughs, with perhaps inflammatory redness round them, in the mouth, œsophagus, and stomach. The blood is dark and coagulates imperfectly. In some cases fatty degeneration of the liver and kidneys may be found.

Treatment.—Any soluble sulphate, such as an ounce of magnesium sulphate or half an ounce of sodium sulphate dissolved in half a pint of water, is the natural antidote, because sulphates and carbolic acid form sulphocarbolates in the blood, and these are harmless. Chalk and saccharated lime are excellent antidotes. Before the antidote is given wash out the stomach, or use some very quickly acting emetic, as apomorphine given hypodermically. Give stimulants freely, such as ether or brandy subcutaneously. Apply hot-water bottles and blankets for collapse.

PHENOLPHTHALEIN.

Phenolphthaleinum.— $C_{20}H_{14}O_4$. *Synonyms.*—Dihydroxy-diphenyl-phthalide. Purgen. Laxoin. Laxatol.

Source.—Obtained by heating phenol with phthalic anhydride and sulphuric acid.

Characters.—A white or yellowish white crystalline or amorphous powder. Odourless and tasteless. Almost insoluble in water. Soluble in alcohol.

Dose.—2 to 5 gr.—12 to 30 centigrms. Best given in cachets or lozenges.

Action and Therapeutics.

An excellent purgative acting directly on the intestinal mucous membrane. It does not gripe, and, being tasteless, is suitable for children. It acts in about six hours, and may therefore be given at bedtime. Very little is absorbed, and the fæces turn a brilliant purple when an alkali is added to them. As it is not depressant it is useful for cases of heart disease.

ACIDUM PICRICUM.

Picric Acid. — $C_6H_2(NO_2)_3OH$. *Synonyms.*—Carbazotic acid. Trinitro-phenol.

SOURCE.—May be obtained by the action of nitric acid on phenol.

CHARACTERS.—Bright yellow crystalline powder. Inodorous, very bitter. Soluble in 90 parts of water and 10 of alcohol, forming intensely yellow solutions which stain the skin yellow.

ACTION AND THERAPEUTICS.

Externally it is a powerful antiseptic, and a one per cent. solution has been used for burns. Being a gastro-intestinal irritant it is not suitable for internal administration. It is used for the determination of albumen in the urine (Esbach's test).

RESORCIN.

Resorcin.—$C_6H_6O_2$. *Synonyms.* — Meta-dihydroxybenzene. Resorcinol.

SOURCE.—Obtained by the interaction of fused sodium hydroxide and sodium metabenzene-disulphonate.

CHARACTERS.—Colourless, shining acicular or prismatic crystals. Faint odour. Taste pungent sweet followed by bitterness. *Solubility.*—1 in 1 of water or alcohol. Freely in olive oil, ether, or glycerin.

Dose, 1 to 5 gr.—6 to 30 centigrms.

ACTION AND THERAPEUTICS.

This substance, originally introduced as an antipyretic, is now rarely given internally, as it is too depressant to the heart. A solution of resorcin in glycerin, 1 in 4, is excellent for removing epidermic scales in chronic skin diseases, and also for getting rid of the scurf in seborrhœa sicca of the scalp. A lotion: Resorcin 1, ether 1, castor oil 1, eau de Cologne 10, alcohol (90 per cent.) 35, is useful for dandriff and alopecia. Resorcin is a powerful antiseptic, and a 5 per cent. solution may be injected into the bladder in cystitis.

CREOSOTUM.

Creosote.

SOURCE.—It is obtained by the distillation of beech tar. It consists chiefly of a mixture in variable proportions of guaiacol ($C_7H_8O_2$), creosol ($C_8H_{10}O_2$), and less of other phenols.

CHARACTERS.—A colourless or slightly yellow liquid, with a very strong peculiar odour and a burning taste. *Solubility.*—1 in 150 in water, freely in alcohol, ether, and glacial acetic acid.

IMPURITY.—Carbolic acid.

INCOMPATIBLE.—Explodes when mixed with oxide of silver.

Dose, 1 to 5 m.—6 to 30 centimils—suspended in mucilage; or as a pill thus, creosote 10 ♏, melted yellow wax 15 gr., powdered curd soap 35 gr. to make 10 pills; or (diluted with three times the quantity of almond oil) in capsules.

Preparation.

Unguentum Creosoti. — Creosote, 1; hard paraffin, 4; white soft paraffin, 5.

ACTION AND THERAPEUTICS.

Creosote has the same actions as carbolic acid, and before that was introduced creosote was used externally as a stimulating antiseptic, a parasiticide, and a slight local anæsthetic; and internally it was given for vomiting and for flatulence. It has been much employed in phthisis, and a few authors claim considerable success. The dose must be gradually pushed until from 30 ♏ to 60 ♏ (2 to 4 mils) are taken at a time. It should be given immediately after meals. The taste may be concealed by putting a few drops in a teaspoonful of rum, but it is best given in capsules. The carbonate, called creosotal (same dose given after meals in capsules), is said to be less liable to cause indigestion. Creosote has also been used as an inhalation with a steam atomizer, and air drawn through 30 ♏ (2 mils) mixed with a pint of water at 140°F. (50°C.) may be inhaled. Bronchiectasis with foul sputum is much benefited

if the patient stay an hour or two a day in a small room in which creosote is being volatilized. An aching tooth may be relieved if it is plugged with cotton wool soaked in creosote.

GUAIACOL.

Guaiacol.—$C_7H_8O_2$.

SOURCE.—May be prepared synthetically or obtained by the fractional distillation of beech tar creosote.

CHARACTERS.—A colourless liquid, or colourless crystals melting at about 28°C. Tarry odour; taste caustic, pungent. Soluble in 80 parts of water, freely in alcohol.

Dose 1 to 5 m.—6 to 30 centimils. Best given in a capsule diluted with three times the quantity of almond oil; or dissolved in cod-liver oil or sherry.

Guaiacol Carbonate.—The carbonic ester of guaiacol. $(C_7H_7O_2)_2CO_3$.

SOURCE.—Obtained by the interaction of carbonyl chloride and sodium guaiacolate.

CHARACTERS.—A white crystalline powder, inodorous and almost tasteless. Insoluble in water, sparingly in alcohol.

Dose, 5 to 15 gr.—3 to 10 decigrms. Best given in a cachet.

ACTION AND THERAPEUTICS.

External.—Guaiacol is antiseptic. If painted over an area of 4 to 20 square inches of skin, it reduces pyrexia, but is not used for this purpose as it causes sweating and collapse.

Internal.—It has been much given in phthisis, for it is believed to aid the destruction of the bacilli in the lungs, but although widely used there is no certain evidence that it is beneficial. The carbonate and the benzoate (dose of either, 5 to 10 gr., 3 to 6 decigrms., in a cachet) have also been given. They are said to have the same effects as guaiacol, and they do not upset the stomach. Chronic osteo-arthritis has been treated by giving guaiacol carbonate with a little potassium iodide in a cachet. It is a

favourite remedy with many prescribers. Styracol (a guaiacol cinnamic ester) is said to be a good preparation combining the advantages of guaiacol and cinnamic acid (*q.v.*), which is an intestinal antiseptic.

IODOFORMUM.

Iodoform. CHI_3.

SOURCE.—Obtained by the action of iodine on ethylic alcohol in the presence of a solution of potassium carbonate.

CHARACTERS.—Small, lustrous, lemon-coloured hexagonal crystals. Has an odour like seaweed. Slightly soluble in water and alcohol, freely in fixed and volatile oils, ether, and chloroform. It contains 96·7 per cent. of iodine.

Dose, ½ to 3 gr.—3 to 20 centigrms.

Preparations.

1. **Suppositoria Iodoformi.** — Iodoform, 2·4 grms.; oil of theobroma, q.s. to make twelve. Each contains 0·2 grm. (about 3 gr.) of iodoform.
2. **Unguentum Iodoformi.** — Iodoform, 1; prepared lard, 9. In India prepared suet should be used instead of prepared lard.

ACTION.

External.—Iodoform is antiseptic and disinfectant, if we may judge by the results obtained in clinical practice; but the experimental evidence that it has no power to hinder the development of *Staphylococcus pyogenes, Bacillus subtilis,* and other micro-organisms is very strong, for all except one or two experimenters state that it has not any antiseptic properties. The reason of these discrepancies is probably this: Iodoform only acts as an antiseptic after its decompoitsion, which results in the liberation of free iodine. The fats always present in tissues dissolve it. When dissolved it is easily decomposed by many agents, such as light, oxygen, living cells, or ptomaines, which would have no effect on it if it were undissolved. By one or more of these it is,

when dissolved after being dusted on a wound, slowly decomposed. Iodine is thus set free rapidly enough to act as an antiseptic, but not rapidly enough to act as an irritant.

Internal.—Not much is known about the internal action of iodoform. It is eliminated in all the secretions, but chiefly in the urine, as iodine, iodides, and iodates. They may be found in the urine for three days after administration of iodoform.

Therapeutics.

External.—Iodoform is much used as a local stimulant, antiseptic, and disinfectant. The clinical testimony to its value is overwhelming.

Its anæsthetic influence diminishes the pain, if there is any, of the sores to which it is applied. It is an excellent application for all sorts of ulcers, sores, and wounds, but especially for tuberculous and syphilitic ulcerations and chancres. Powdered iodoform is usually sprinkled on them. Wounds and venereal sores are often painted with a solution of it in collodion (1 in 12 of flexible collodion). This is an excellent application. Iodoform is useful as an insufflation (iodoform 1, starch 2) for ozæna, ulcers of the mouth and throat, and tuberculous ulcers of the larynx. Often $\frac{1}{3}$ gr. (24 milligrms.) of acetate of morphine is added. An emulsion (iodoform 1, moistened with alcohol; boiling water 2, glycerin 7) is very useful for injection into sinuses or abscess cavities. It has been used in the form of a bougie for the urethra and for the nose. The suppository is useful in painful conditions of the rectum. It is occasionally employed for pruritus, and to relieve the pain of neuralgia. Many attempts have been made to get rid of its odour; balsam of Peru, musk, and 2 per cent. of creolin have been used, but oil of geranium (1 to 25) is best.

Internal.—Iodoform has not been found to be of any use internally. It has been tried unsuccessfully in phthisis and many other conditions.

Toxicology.

Curious symptoms, often severe and sometimes ending in death, are occasionally observed after the application of iodoform to a raw surface. They are a quick pulse, gastro-intestinal irritation, fever, rapid collapse, melancholia, hallucinations, dilated pupils, extensive erythema, and perhaps eczema. These symptoms vary much in severity, and it is rare for more than two or three of them to be present at once. It is not known how iodoform causes them. The mental symptoms are the most characteristic. Fatty degeneration of the liver and muscles may occur. Stimulants, diaphoretics, and sponging the skin with warm water are recommended.

Iodoform-like Substances.—(Not official.)

There are many of these in the market. They all depend for their antiseptic properties on the iodine in them. They have no advantage over iodoform, except that some of them have no odour. The following are the chief:

Iodoform contains	96·7	per cent. of iodine
Iodol (Iodopyrrol)	90·0	,, ,, ,,
Losophan (Iodocresol)	80·0	,, ,, ,,
Di-iodo-salicylic acid	66·0	,, ,, ,,
Sozoiodol (Sozionic Acid) contains	54·0	,, ,, ,,
Iodo-salicylic acid	50·0	,, ,, ,,
Aristol (Thymol Iodide) contains	46·0	,, ,, ,,

NAPHTHOL.

Beta-naphthol or Beta-mono-hydroxy-naphthalene. $C_{10}H_7OH$.

Source.—Prepared from naphthalene-sulphonic acid.

Characters and Tests.—White shining laminar crystals or in powder. Odour like phenol; taste pungent. *Solubility.*—Easily in alcohol, ether, chloroform, benzene, 1 in 1000 cold water, 1 in 8 of olive oil, 1 in 80 of vaseline.

Dose, 3 to 10 gr.—2 to 6 decigrms.—in a cachet.

Action and Therapeutics.

A powerful antiseptic. A 10 per cent. ointment cures scabies, and stronger may be used for ringworm. It has been used for psoriasis. It is given as an

intestinal antiseptic, but it is difficult to say how far any improvement which follows is due to rest or dieting, and it is possible that, as micro-organisms play a part in healthy digestion, a really efficient intestinal antiseptic might do more harm than good. It is useful for decomposition in a dilated stomach. Used for long periods it may cause nephritis. Large doses cause symptoms like those due to carbolic acid.

Scarlet Red.—(Not official.)

Amido-azo-toluene tetranaphthol. A red powder soluble in oils and fats. An excellent stimulating ointment (4 to 8 per cent. with a lard basis). The dressing should be changed night and morning.

Naphthalene.—(Not official.) $C_{10}H_8$.

Synonym.—Naphthalin, Tar Camphor.

Dose, 3 to 12 gr.—2 to 8 decigrms.—in a cachet.

It is an antiseptic and is much used instead of camphor to prevent the ravages of moth in furs. Internally it is used for the same purposes as naphthol and as an anthelmintic for tape and round worms.

CRESOL.

Cresol.—A mixture of isomers of the formula C_7H_7OH obtained from coal tar. Should be preserved in stoppered amber-coloured bottles.

Synonym.—Cresylic acid.

Characters.—A straw-coloured liquid, becoming brown on keeping or on exposure to light. Soluble in 50 parts of water.

Dose, 1 to 3 m.—6 to 18 centimils.

Preparation.

Liquor Cresol Saponatus.—Cresol, 50; castor oil, 35; potassium hydroxide, 8; distilled water, 100.

Action.

A more powerful antiseptic than carbolic acid. It is excreted in the urine as cresyl-sulphonic acid.

Therapeutics.

It is used in surgery and generally as an antiseptic, and may with advantage replace carbolic acid

in many lotions and ointments as it is less poisonous and less caustic, but damages the tissue cells if applied to wounds. It may be given internally with olive oil in capsules as a gastro-intestinal disinfectant. It often benefits whooping-cough if volatilized in the sick room. The following substances: creolin, cyllin, chinosol, atophan, lysol, izal, ialine, kerol, are widely used and are very similar to cresol. Cresol and its allies being so common have led to many cases of poisoning. The symptoms are like those of carbolic acid poisoning. The stomach should be immediately washed out and then white of egg or olive oil should be given to prevent the re-absorption of any of the poison excreted into the stomach. Treatment must be prompt and general stimulants will be required.

Creolin.—(Not official.)

This is a dark yellow liquid derived from coal tar. It is a mixture of cresols. Jeyes' disinfectant and other preparations contain it. It is a powerful germicide. It forms a white emulsion with water, is cheap, and has a pleasant smell. Toxic symptoms are known, but are very rare.

Cyllin.—(Not official.)

A dark liquid coal-tar derivative strongly antiseptic. It is purified creolin. It forms a white emulsion with water, and a lotion (1 in 200) is often used. It is one of the best intestinal disinfectants, and capsules containing 2 or 3 m. (12 to 18 centimils) for an adult are given for colitis, summer diarrhoea, dysentery, and similar diseases. It may be given flavoured with syrup and suspended, but the taste is nasty.

Oxoquin.—(Not official.) *Synonym.*—Chinosol.

The potassium salt of a compound of oxychinoline and sulphuric acid. A coal-tar derivative. Used as a surgical antiseptic; 15 grains to the pint equal 1 in 40 of carbolic acid.

Quinophan.—(Not official.) *Synonym.*—Atophan.

A substance allied to chinosol. Renders the renal cells more permeable to, and thus increases, uric acid in the urine. Dose 10 to 20 gr. (6 to 12 decigrms.) in a cachet.

Lysol and Izal.—(Neither official.)

These coal-tar derivatives are powerful antiseptics, are not highly poisonous, and are, when mixed with water (Lysol

2 per cent., Izal ½ per cent.), used in surgery. Lysol is very popular. It does not affect instruments, but may make them difficult to hold, as it is a solution of tar oils in a neutral soap.

Ialine.—(Not official.)

A powerful antiseptic containing 50 per cent. cresol May be used as a surgical and general antiseptic.

Kerol.—(Not official.)

A coal-tar derivative of high antiseptic power suitable for the same uses as other antiseptics. Capsules containing 3 ♏ are employed as intestinal disinfectants.

Flavine.—(Not official.)

A coal-tar product, also called Acriflavine. A brick red powder, used in aqueous solution of 1 in 1000. Very powerful antiseptic, acts in the presence of organic matter and stimulates connective tissue cells.

Brilliant Green.—(Not official.)—A coal-tar product. Very powerful antiseptic.

Benzyl Benzoate.—(Not official.) *Synonym.*—Spasmodin. Dose, 10 to 30 m. dissolved in alchohol or suspended. This liquid relaxes spasm of unstriped muscle and has been used for excessive intestinal paralysis, vesical spasm, dysmenorrhœa, and asthma.

FORMALDEHYDE—(Not official.)

1. Liquor Formaldehydi (Official). *Synonym.*—Formalin. An aqueous solution containing in 100 millilitres not less than 36 and not more than 38 grammes of formaldehyde, CH_2O. This may be obtained by the limited oxidation of methyl alcohol.

Characters.—A colourless liquid with a characteristic, pungent odour. Miscible with water and alcohol in all proportions. Caustic when applied to the skin.

2. Liquor Formaldehydi Saponatus.—(Official.)—Soft soap, 40; alcohol (90 per cent.), 30; solution of formaldehyde, 20; distilled water to 100.

Action and Therapeutics.

Formaldehyde vapour when inhaled is very irritating to the air-passages, and causes violent sneezing.

Formalin is powerfully caustic; diluted with ten times its bulk of water it is used for corns, and is a good preservative for museum specimens, which do not shrink in it. Diluted twenty-five times it is used

as an histological hardening agent. It is an excellent germicide, and has been employed (30 per cent.) with good results for ringworm of the scalp.

It is not much used in surgery as it retards healing, but it is a most powerful disinfectant and does not destroy coloured fabrics. It is believed to act by combining with proteins. A two per cent. solution may be used. Formalin 1, water 500, is an admirable wash for a foul mouth. Formamint tablets, the principal ingredient is formaldehyde, are advertised for disinfection of the mouth.

Paraform—a white amorphous substance and a polymer of formaldehyde—on being heated by an enclosed spirit lamp sublimes, and, combining with the products of combustion, is converted into the vapour of formaldehyde. This has been recommended as a disinfectant for sick rooms after illness, but only surfaces are disinfected, for the vapour does not penetrate thin dusters.

Lysoform—a liquid formaldehyde potash soap—is a powerful antiseptic, inodorous and miscible with water. A 2 per cent. solution is used for many disinfectant and surgical purposes. A mouth wash, tooth powder, and soap are employed.

HEXAMINE.

Hexamina.—Contains not less than 98 per cent. of pure hexamethylene tetramine, $C_6H_{12}N_4$.

Synonyms. — Urotropine, cystamin, cystogen, hexamethylenetetramine.

SOURCE.—Obtained by the interaction of ammonia with formic aldehyde.

CHARACTERS.—Colourless crystals or crystalline power. Inodorous. Taste at first sweetish, bitter afterwards. Soluble in 1·5 parts of water and in 8 of alcohol (90 per cent.).

Dose, 5 to 15 gr.—3 to 10 decigrms.

ACTION AND THERAPEUTICS.

Hexamine is the most powerful urinary antiseptic we have; it acts by the formation of form-

aldehyde in the urine, in proportion as this is acid, therefore acid phosphate of sodium should also be given, but not with urotropine as chemical reaction occurs. It often keeps the urine sweet in cases of cystitis; also, it is useful for bacilluria, for the nocturnal incontinence of children if due to bacillus coli in the urine, and to disinfect the urine when typhoid bacilli are excreted in it. Occasionally it causes a measly itching rash, rarely it causes hæmaturia. Solutions of it dissolve uric acid, but there is no evidence that the administration of it increases the solubility of uric acid in the urine. Helmitol and Hetraline (both soluble in water; dose of each, 5 to 10 gr., 3 to 6 decigrms.) are bodies of a similar constitution and action.

CLASS VII.—**The Remaining Carbon Compounds.**

These have no relationship to each other, and each must therefore be considered separately.

ACIDUM HYDROCYANICUM DILUTUM.

Diluted Hydrocyanic Acid. Hydrogen Cyanide.

Synonym.—Dilute Prussic acid.

SOURCE.—Prepared by the interaction of potassium ferrocyanide and sulphuric acid. It is a 2 per cent. by weight solution of hydrogen cyanide, HCN. Scheele's prussic acid is a 4 or 5 per cent. solution.

CHARACTERS.—A colourless, volatile, faintly acid liquid, having an almond-like odour. Very unstable; to preserve it best, it should be kept in a dark place in small inverted amber-coloured stoppered bottles. Old specimens may be inert. Sp. gr. 0·997. *Strength.*—2 per cent.

INCOMPATIBLES.—Salts of silver, copper, and iron, red oxide of mercury, and sulphides.

Dose, 2 to 5 m.—12 to 30 centimils.

Preparation.

Tinctura Chloroformi et Morphinæ Composita.—$\frac{1}{2}$ m of Acidum Hydrocyanicum Dilutum in 10 m, *i.e.* 5 per cent. (*See* pp. 296, 297.)

Dose, 5 to 15 m.—3 to 10 decimils.

Hydrocyanic acid is contained in Aqua Laurocerasi, and also in oil of bitter almonds (non-official). It is probably the active ingredient of the preparations of Virginian Prune.

Action.

External.—Hydrocyanic acid can pass through the epidermis, and then it paralyses the terminations of the sensory nerves; thus it is a local anæsthetic and sedative. It is very rapidly absorbed from raw surfaces, and may cause poisoning if applied to them.

Internal.—*Alimentary tract.*—It is quickly absorbed by mucous membranes, and has the same anæsthetic and sedative effect on the mouth and stomach as on the skin. It must always be employed very dilute. A single drop of the pure acid placed inside the eye of even a moderately large animal will kill it instantly.

Blood.—If death takes place almost immediately after the administration of the drug, all the blood in the body is of a bright arterial tint; but if death does not occur for some little time (within half an hour), the blood is of a dark venous colour. The primary transitory reddening of the venous blood is due to the fact that the hæmoglobin in it is still oxidized, because prussic acid retards the absorption of oxygen by the tissues, so lowering metabolism. The subsequent darkening of the arterial blood is due to the fact that it has lost its oxygen, and contains carbonic acid gas; why this should be is not certain, but probably it depends upon the asphyxia consequent upon the action of hydrocyanic acid on the respiratory centre. If blood be shaken up with prussic acid, after some time oxyhæmoglobin is converted into cyanohæmatin, the oxygen being turned out. Prussic acid added to drawn blood alters the shape of the red blood-corpuscles. Neither of these actions is seen in life, for sufficient prussic acid to cause them would kill before they could take place. Lactic acid and sugar are found in the urine if much prussic acid has been taken. They are often present when from any cause oxidation of tissues is imperfect.

Heart.—Large doses cause instantaneous diastolic arrest. As this is also true if the drug is applied locally, we may conclude that large doses paralyse the heart directly. But prussic acid acts also on the cardiac centre in the medulla. A small dose will cause a slowing of the pulse from stimulation of the vagus centre, and the stoppage from larger doses is due both to the direct action on the heart and to that on the medulla.

Vaso-motor system.—The vaso-motor centre in the medulla is first briefly stimulated, and the blood pressure rises, but soon it is profoundly paralysed; blood-pressure therefore falls very low.

Respiration.—The respiratory centre is paralysed even more readily than the cardiac or vaso-motor centres, consequently the respirations quickly diminish both in force and frequency. Unless the heart has been instantaneously stopped by a large dose, asphyxia is the cause of death, and the heart goes on beating after the respirations have stopped. If the dose be quite small, all three centres may be at first transitorily stimulated, so that the pulse and respirations may be increased in frequency, and blood-pressure may rise.

Nervous system.—*Cerebrum.*—Medicinal doses of prussic acid have no effect on the cerebrum. Toxic doses cause deep insensibility and coma. In man convulsions are rarely seen; in animals they are common. It is probable that the coma and convulsions are due to the direct effect on the brain, but they may in part be due to the altered circulation through it, or to the asphyxia.

Peripheral nerves and muscles.—In animals dead of prussic acid poisoning these are unexcitable. This paralysing effect is due to a direct action on the nerves and muscles themselves, for it does not occur in the peripheral part of a limb if it is connected with the rest of the body only by its nerve.

In this case, as no blood is circulating through the distal part of the limb, no prussic acid reaches it; but if the acid be applied locally to the severed limb, the nerve and muscles are paralysed. It will be noticed that it depresses all functions, indeed it is a powerful protoplasmic poison. The pupil is dilated.

Kidneys.—We do not know of any effect of prussic acid on the kidneys. Part of it is excreted as a sulphocyanide. It slightly reduces the temperature.

Therapeutics.

External.—Lotions of about 10 ♏ (6 decimils) of the diluted acid to 1 fl. oz. (30 mils) of water are valuable for allaying itching due to any cause. If the skin is abraded they must not be used. The vapour is used to disinfect ships.

Internal.—Small doses, 2 to 4 ♏ (12 to 25 centimils) of the diluted acid, are used for their sedative effect on the nerves of the stomach, to allay vomiting, and to relieve gastric pain, whatever may be their cause, and often with good effect. A useful way of giving it is in an effervescing draught. It is a common ingredient of cough mixtures, for by its depressing effect on the central nervous system it diminishes reflex excitability, and is consequently most serviceable for a dry hacking cough, by means of which nothing is expectorated.

Toxicology.

With a large dose the symptoms usually begin in a few seconds; it is rare for them to be delayed more than two minutes. The patient is perfectly insensible, the eyes are fixed and glistening, the pupils dilated, the limbs flaccid, the skin cold and clammy. The respiration is slow, deep, and convulsive; the pulse is almost imperceptible. *Post mortem.*—There may be an odour of prussic acid about the body, which is very livid. The fingers are clenched, the jaws firmly closed, and there is froth at the mouth; the eyes are fixed and glistening,

and the pupils are dilated. The stomach may be a little reddened. The blood is very dark.

Treatment.—Wash out the stomach immediately. If emetics are available large doses must be given very promptly, for every moment is important. Give ether or brandy and $\frac{1}{50}$ gr. of atropine subcutaneously. Use inhalations of ammonia and artificial respiration.

GLUSIDUM.

Gluside. Benzoic sulphinide, $C_7H_5NSO_3$.

Synonyms.—Glucusimide, Saccharin.

Source.—It is the anhydride of orthosulphamido-benzoic acid derived from toluene by a complicated process.

Characters.—A light, white, minute crystalline powder. Its solution has an intensely sweet taste; 1 of saccharin is equal to 300 of cane sugar. *Solubility.*—1 in 400 of cold water; 1 in 24 of boiling water; 1 in 500 of chloroform; 1 in 25 of alcohol (90 per cent.); 1 in 48 of glycerin. It unites with alkaline hydrates and carbonates, evolving from the latter carbonic acid gas, and yielding soluble saccharin, which has lost none of its sweetness, and is very soluble in water.

Impurities.—Commercial saccharin is not a pure or uniform product; it often contains less than 50 per cent. of actual glusidum.

Action and Therapeutics.

Glusidum is an antiseptic, but is not used as such. It is employed as a **sweetening agent** when from any cause, as diabetes, sugar cannot be taken. It may be given as tablets or with sodium carbonate to form soluble saccharin. Elixir Glusidi (B.P.C.)—containing glusidum, sodium bicarbonate, alcohol (90 per cent.) and distilled water —is excellent for covering the taste of nauseous medicines. Usually 20 ♏ (12 decimils) are required for a four-ounce mixture.

PARAFFINUM LIQUIDUM.

Liquid Paraffin.

Liquid paraffin is a mixture of liquid hydrocarbons.

Characters.—A transparent colourless, odourless, tasteless clear oily liquid. Sp. gr. 0·860 to 0·890.

In this case, as no blood is circulating through the distal part of the limb, no prussic acid reaches it; but if the acid be applied locally to the severed limb, the nerve and muscles are paralysed. It will be noticed that it depresses all functions, indeed it is a powerful protoplasmic poison. The pupil is dilated.

Kidneys.—We do not know of any effect of prussic acid on the kidneys. Part of it is excreted as a sulphocyanide. It slightly reduces the temperature.

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PARAFFINUM LIQUIDUM.

Liquid Paraffin.

Liquid paraffin is a mixture of liquid hydrocarbons.

Characters.—A transparent colourless, odourless, tasteless clear oily liquid. Sp. gr. 0·860 to 0·890.

Uses.

It is unabsorbed from the alimentary canal, but is an excellent aperient for many persons, producing if taken over-night an easy motion of the bowels without any griping. With some it has little action, and in others it may pass through the bowels and out of the anus without bringing any motion with it. Then the patient may be unaware that the paraffin is passed. It is a popular aperient with those whom it suits and may be taken for a long period. The usual dose is ½ to 1 fl. oz. (15 to 30 mils).

PARAFFINUM DURUM.

Hard Paraffin.

Hard paraffin is a mixture of solid hydrocarbons.

CHARACTERS.—A somewhat translucent, colourless, crystalline, inodorous, tasteless solid, slightly greasy to the touch. Melts at 50° to 60°C., burns with a bright flame. *Solubility.* —Freely in ether and chloroform; slightly in alcohol; not at all in water.

PARAFFINUM MOLLE.

Soft Paraffin. *Synonym.*—Vaseline.

Soft paraffin is a mixture of semi-solid hydrocarbons.

CHARACTERS.—A white or yellowish, translucent, soft and greasy semi-solid, free from any unpleasant odour or flavour. Melts at 42° to 46°C. Insoluble in water.

Preparation.

Unguentum Paraffini.—Hard Paraffin, 27; soft paraffin, 70; white beeswax, 3. When paraffin ointment is the basis of white ointments, it should be made from white soft paraffin; when it is the basis of coloured ointments it should be made from yellow soft paraffin. In order to meet the exigencies of climate and temperature the proportion of hard and soft paraffin may be varied.

USES.

As paraffins cannot become rancid, or irritate the skin, and as they are not acted upon by acids or alkalies, or by powerful oxidizing agents (*e.g.* chromic acid), they form a very good basis for many ointments; but as they are absorbed with difficulty, they are not a suitable vehicle for the absorption of drugs by the skin. Therefore paraffin ointment should only be used as a basis when it is desired that the ointment shall protect sores or wounds. A teaspoonful of vaseline is a good aperient. Like liquid paraffin, it may be taken for a long period, and does not gripe. Both it and liquid paraffin may be flavoured to taste.

BENZENUM.

Benzene.—A mixture of homologous hydrocarbons obtained from light coal-tar oil. It contains about 70 per cent. of benzene, C_6H_6, and 20 to 30 per cent. toluene, C_6H_5,CH_3.

CHARACTERS.—A colourless volatile liquid free from opalescence, with strong characteristic odour. Sp. gr. 0·88 to 0·887.

Used to make Liquor Caoutchouc and Charta Sinapis.

Called Benzol, B. P. 1898.

ACTION AND THERAPEUTICS.

One free application will destroy pediculi capitis and pediculi pubis.

Purified benzol (dose, 5 to 20 ℳ, 3 to 12 decimils) on sugar, or suspended in mucilage, has been given for winter cough and for whooping-cough.

CARBON DISULPHIDUM.

Carbon Disulphide. CS_2.

SOURCE.—May be prepared by combining carbon and sulphur at a high temperature.

CHARACTERS.—Clear, colourless, highly refractive liquid, with characteristic odour. Sp. gr. 1·268 to 1·269. Very slightly soluble in water, but soluble in alcohol, ether, chloroform, fixed and volatile oils.

Called Carbonis Bisulphidum, B. P. 1898.

Uses.

Used to make Liquor Caoutchouc and Pilula Phosphori.

Carbon Dioxide.—(Not official.) *Synonym.*—Carbonic snow.

The gas in cylinders at a pressure of 65 atmospheres is allowed to escape into some suitable receptacle, such as a towel rolled so as to form a tube. The gas condensing forms a semi-solid snow, which can be formed into a stick or crayon. It can be moulded or cut with a knife to form a pencil which, covered to protect the hand, may be applied to nævi, port-wine stains, lupus or rodent ulcer. The pencil should be of such a size that when pressed down on the diseased part it covers the whole of it, if small, or a part 1 inch in diameter if large. The application is usually for about half a minute or a little longer. On removal, some simple ointment is applied. This treatment is excellent for removing the above conditions.

Part II.—ORGANIC MATERIA MEDICA.

Section I.—SUBSTANCES DERIVED FROM THE VEGETABLE KINGDOM.

The drugs comprehended in this section may be arranged in many ways, but there are objections to each. Inasmuch as the medical student has to be well acquainted with the actions of these drugs in health and disease, those which act similarly will be grouped together.

GROUP I.

Drugs acting chiefly on the Nervous System.

The chief of these may be classified as follows.

Class I.—Acting on the cerebrum.

A. Cerebral depressant or soporific:

Opium.

B. Cerebral excitants:

Deliriants:
- **Belladonna.**
- **Stramonium.**
- **Datura.**
- **Hyoscyamus.**

(Belladonna, Stramonium, Datura, Hyoscyamus: Also act on nerve endings in glands and involuntary muscle. Possibly **Grindelia** also.)

- **Cannabis Indica.**

Caffeine.
Theobromine.
Guarana.

Class II.—Acting on the spinal cord.

A. Exciting the anterior cornua. **Nux Vomica.**

B. Depressing the anterior cornua. **Physostigmine** (also acts like pilocarpine), **Gelsemium.**

Class III.—Acting on the nerves.

A. Depressing the motor nerve endings. **Conium, Tobacco, Curare.**

B. Depressing the sensory nerve endings. **Cocaine. Benzamine. Kava.**

C. Stimulating the secretory nerve endings. **Pilocarpine, Muscarine.**

D. Depressing the secretory nerve endings. **Agaricin** (also the **Belladonna** group).

Class I.—Vegetable Drugs acting chiefly on the Cerebrum.

OPIUM.

Opium.—The juice obtained by incision from the unripe capsules of *Papaver somniferum*, the white poppy, inspissated by spontaneous evaporation. Any suitable variety of opium may be used to obtain the liquid extract and the tincture of their respective alkaloidal strengths, provided that when dry it contains not less than 7·5 per cent. of anhydrous morphine; but otherwise the preparations of opium must be made from opium of such a strength that when dried and powdered it shall yield from 9·5 to 10·5 *per cent. of morphine.* Opium containing more morphine may be diluted to that strength by the addition of opium containing between 7·5 and 10·5 per cent. of morphine or by milk sugar.

Characters.—Rounded, irregular, or flattened masses, commonly from 250 to 1000 grms. in weight. When fresh it is plastic, moist, coarsely granular, reddish or chestnut-brown, but becoming harder by keeping, and darkening to blackish brown. Odour strong, peculiar, narcotic. Taste nauseously bitter.

This official variety is commonly called *Asia Minor opium* (*Synonyms.*—Smyrna, Turkey, and Levant opium).

Varieties.—In addition to Asia Minor opium the following are met with in commerce. (*a*) Constantinople opium, small lenticular masses, ¼ to ½ lb. in weight, and enclosed in a poppy leaf. Sometimes the terms Turkey and Levant opium include this. (*b*) Egyptian opium. Flat, more or less circular cakes, two or three inches in diameter, reddish hue internally, covered with a leaf externally. Persian, Indian, English, French, and German opiums are rarely met with in England.

Composition.—(1) *Alkaloids.*—At least eighteen in number. Most are combined with meconic acid, some with sulphuric acid, and some are free. Some morphine salts and codeine and its phosphate are official. Morphine, codeine, narcotine, and thebaine are important. The following are the alkaloids existing in opium:

Morphine (up to 12 per cent.).	Papaverine.
Codeine (up to ·6 per cent.).	Pseudo-morphine.
Thebaine (up to ·3 per cent.).	Protopine.
Narcotine (also called Anarcotine).	Oxynarcotine.
Narceine.	Cryptopine.

Hydroctarnine.
Laudanine.
Laudanosine.
Meconidine.
Rhœadine.
Codamine.
Gnoscopine.
Lanthoptine.

(2) *Neutral bodies.*—Two in number:
Meconin.
Meconiasin.

(3) *Organic acids.*—Two in number:
Meconic acid.
Thebolactic acid.

(4) *Water*, 16 *per cent.*

(5) *Mucilage, resin, albumen, glucose, fats, essential oil, caoutchouc, odorous substances, and salts of ammonium, calcium, and magnesium.*

The following analysis shows how specimens vary.

	Morphine per cent.	Anarcotine per cent.
Patna opium	3·98	6·36
Smyrna opium	8·27	1·94

IMPURITIES.—Water, stones, fruits, leaves, starch, &c. 100 gr. dried at 100°C. should yield **9·5 to 10·5 gr. of morphine.**

INCOMPATIBLES.—Perchloride of iron gives a deep red colour (due to meconic acid). Salts of zinc, copper, and arsenic, silver nitrate, acetate and subacetate of lead, give precipitates of meconates, sulphates, and colouring matters. All tannin-containing preparations precipitate codeine tannate. Fixed alkalies, their carbonates, and ammonia precipitate morphine and narcotine. The small amount of glucose in opium may cause it to explode when made into a pill with nitrate of silver.

Dose, $\frac{1}{2}$ to 2 gr.—3 to 12 centigrms.

For Dangerous Drugs Act Regulations for opium, morphine and diamorphine, *see* p. 41.

Preparations.

1. Extractum Opii Siccum.—Sliced opium, distilled water. *Standardized to contain* 20 *per cent. of morphine.* (To obtain the correct strength, stronger and weaker extracts may be mixed, or stronger diluted with water or calcium phosphate.)

This is Extractum Opii, B. P. 1898.

Dose, $\frac{1}{4}$ to 1 gr.—16 to 60 milligrms.

2. Extractum Opii Liquidum.—Dr extract of opium, 37·5; alcohol (90 per cent.), 200; water to produce 1000. *Standardized to contain* 0·75 *per cent.*

of morphine. (Official imitation of Liquor Opii Sedativus or Battley's Sedative Solution.)

Dose, 5 to 30 m.—3 to 18 decimils.

3. Pilula Plumbi cum Opio.—Powdered opium, 12; lead acetate, 80; syrup of glucose, 8. *Strength of opium.*—1 in 8.

Dose, 2 to 4 gr.—12 to 25 centigrms.

4. Pilula Saponis Composita.—Powdered opium, 1; hard soap, 3; syrup of glucose, 1. *Strength of opium.*—1 in 5. (Often wrongly called Pilula Opii.)

Dose, 2 to 4 gr.—12 to 25 centigrms.

5. Pulvis Cretæ Aromaticus cum Opio.—Powdered opium, 2·5; aromatic chalk powder, 97·5. *Strength of opium.*—1 in 40.

Dose, 10 to 60 gr.—6 to 40 decigrms.

6. Pulvis Ipecacuanhæ Compositus. *Synonym.*—Dover's powder. Powdered opium, 1; ipecacuanha, 1; potassium sulphate, 8. *Strength of opium.*—1 in 10.

Dose, 5 to 15 gr.—3 to 10 decigrms.

7. Pilula Ipecacuanhæ cum Scillâ.—Compound ipecacuanha powder, 3; squill, 1; ammoniacum, 1; syrup of glucose, q.s. *Strength of opium.*—1 in 20.

Dose, 4 to 8 gr.—25 to 50 centigrms.

8. Pilula. Ipecacuanhæ cum Urginea.—Compound ipecacuanha powder, 3; urginea, 1; ammoniacum, 1; syrup of glucose, q.s. *Strength of opium,* 1 in 20.

Dose, 4 to 8 gr.—25 to 50 centigrms.

9. Pulvis Kino Compositus.—Powdered opium, 1; kino, 15; cinnamon, 4. *Strength of opium.*—1 in 20.

Dose, 5 to 20 gr.—3 to 12 decigrms.

10. Pulvis Opii Compositus.—Powdered opium, 10; black pepper, 15; ginger, 30; caraway, 42; tragacanth, 3. *Strength of opium.*—1 in 10.

Dose, 5 to 15 gr.—3 to 10 decigrms.

11. Suppositoria Plumbi Composita.—Powdered opium, 0·8 grm.; lead acetate, 2·4 grm.; oil of theobroma, q.s. to make twelve. *Strength of opium.*—1 gr. (0·067 grm.) in each.

12. Tinctura Opii. *Synonym.*—Laudanum. Powdered opium, 200; alcohol (90 per cent.), and

water, q.s. *Standardized to contain* 1·0 *per cent. of anhydrous morphine.* That is 1 grm. in 100 millilitres or 1 gr. in 110 ♏. It is one-third stronger than the corresponding preparation, B. P. 1898.

Dose, 5 to 15 m.—3 to 10 decimils for repeated, 20 to 30 m.—12 to 18 decimils—for single administration.

A preparation of opium called Nepenthe is one-third less strong than Tinctura Opii. Sydenham's laudanum is a tincture of opium flavoured with saffron. Acetum Opii Crocatum (black drop) is three times as strong as Tinctura Opii.

13. Linimentum Opii.—Tincture of opium and soap liniment, equal parts. *Strength of morphine.*—0·5 per cent.

14. Tinctura Camphoræ Composita. *Synonym.*—Paregoric. Tincture of opium, 50; benzoic acid, 5; camphor, 3; oil of anise, 3; alcohol (60 per cent.) to make 1000. *Strength.*—Contains 5 milligrms. morphine in 10 millilitres (0·05 per cent.) or $\frac{1}{37}$ gr. in 1 fl. dr.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

15. Tinctura Opii Ammoniata. *Synonym.*—Scotch paregoric. Dissolve benzoic acid, 20; and oil of anise, 5, in alcohol (90 per cent.), 600. Add tincture of opium, 100, solution of ammonia, 200, and alcohol (90 per cent.) to make 1000. *Strength.*—This contains 0·1 grm. of morphine in 100 millilitres or $\frac{1}{10}$ gr. in 110 ♏. It contains $\frac{1}{10}$ less morphine than in B. P. 1898.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

16. Unguentum Gallæ cum Opio.—Powdered opium, 75; ointment of galls, 925. *Strength of opium.*—1 in $13\frac{1}{3}$.

17. Unguentum Myrobalani cum Opio.—Powdered opium, 75; myrobalan ointment, 925. *Strength of opium.*—1 in $13\frac{1}{3}$.

It will be noticed that—

From *Extractum Opii Siccum* there is prepared Extractum Opii Liquidum.

From *Pulvis Ipecacuanhæ Compositus* there is prepared Pilula Ipecacuanhæ cum Scillâ and Pilula Ipecacuanhæ cum Urginea.

From *Tinctura Opii* there are prepared Linimentum Opii, Tinctura Camphoræ Composita, and Tinctura Opii Ammoniata.

The following list, in which the doses are arranged approximately according to those given in the Pharmacopœia, may assist the student. The strength of opium in preparations standardized to contain a definite amount of morphine is of course only approximate:

Strength of Opium.	*Name.*	*Approximate Dose.*
1 in $\frac{1}{2}$	Ext. Opii Siccum	$\frac{1}{4}$–1 gr. 16 to 60 milligrms.
1 in 5	Pil. Saponis Co.	2–4 gr. 12 to 25 centigrms.
1 in 8	Pil. Plumbi c̄ Opio	
1 in 10	Pulv. Opii Co.	2–10 gr. 12 to 60 centigrms.
1 in 20	Pil. Ipecac. c̄ Scillâ	
1 in 20	Pil. Ipecac. c̄ Urginea	
1 in 9	Tinct. Opii	5–20 gr. or ♏ 3 to 12 decigrms. or decimils.
1 in 10	Pulv. Ipecac. Co.	
1 in 12	Ext. Opii Liq.	
1 in 20	Pulv. Kino Co.	
1 in 40	Pulv. Cret. Aromat. c̄ O.	10–40 gr. 6 to 40 decigrms.
1 in 90	Tinct. Opii Ammon.	30–60 ♏ 2 to 4 mils.
1 in 220	Tinct. Camph. Co.	
1 gr. in each	Suppositoria Plumbi Co.	
1 in $13\frac{1}{3}$	Ung. Gallæ c̄ Opio	
1 in $13\frac{1}{2}$	Ung. Myrobalani c̄ Opio	
1 in 18	Linimentum Opii	

Morphinæ Hydrochloridum. — Morphine Hydrochloride. $C_{17}H_{19}NO_3,HCl,3H_2O$.

Source.—The hydrochloride of an alkaloid obtained from opium.

Characters.—White acicular, silky prisms or a white powder of minute cubical crystals. *Solubility.*—1 in 25 of water; 1 in 50 of alcohol (90 per cent.); 1 in 8 of glycerin.

Incompatibles.—Salts of lead, iron, copper, mercury, and zinc; alkaline earths; lime water; Liquor Arsenicalis; all substances containing tannin.

Dose, $\frac{1}{8}$ to $\frac{1}{2}$ gr.—8 to 30 milligrms.

Preparations.

1. **Liquor Morphinæ Hydrochloridi.**—Morphine Hydrochloride, 1; dilute hydrochloric acid, 2; alcohol (90 per cent.), 25; water, to make 100. *Strength.*—1 per cent. or 1 gr. in 110 ♏, 1 grm. in 100 millilitres, or about $4\frac{1}{2}$ gr. of the hydrochloride to 1 fl. oz.

Dose, 10 to 60 m.—6 to 36 decimils.

2. **Suppositoria Morphinæ.**—Morphine Hydrochloride, 0·2 grm.; oil of theobroma, q.s. to make twelve. *Strength.*—1 in 60. Each contains 0·017 grm. ($\frac{1}{4}$ gr.) of morphine hydrochloride.

3. **Tinctura Chloroformi et Morphinæ Composita.**—*See* p. 297. *Strength.*—$\frac{1}{11}$ gr. in 10 ♏.

Dose, 5 to 15 m.—3 to 10 decimils.

4. **Trochiscus Morphinæ.**—Morphine Hydrochloride, 0·002 grm.; with tolu basis. *Strength.*—0·002 grm. or $\frac{1}{33}$ gr. in each.

5. **Trochiscus Morphinæ et Ipecacuanhæ.**—Morphine Hydrochloride, 0·002 grm.; ipecacuanha, 0·006 grm.; with a tolu basis. *Strength.*—0·002 grm. of morphine hydrochloride or $\frac{1}{32}$ gr. in each.

Morphinæ Acetas.—Morphine Acetate. $C_{17}H_{19}NO_3,C_2H_4O_2,3H_2O$. The use of the acetate is diminishing, as it is unstable, losing acetic acid on exposure to air.

Source.—Morphine is dissolved in acetic acid and water, and the neutral solution is evaporated.

Characters.—A white crystalline or amorphous powder. *Solubility.*—1 in $2\frac{1}{2}$ of water. Many specimens are not so soluble as this. 1 in 100 of alcohol (90 per cent.); 1 in 5 of glycerin.

Incompatibles.—As morphine hydrochloride.

Dose, $\frac{1}{8}$ to $\frac{1}{2}$ gr.—8 to 30 milligrms.

Preparation.

Liquor Morphinæ Acetatis.—Morphine Acetate, 1; dilute acetic acid, 2; alcohol (90 per cent.), 25; distilled water, to make 100. *Strength.*—1 per cent. or 1 gr. in 110 ♏, 1 grm. in 100 millilitres, or about $4\frac{1}{2}$ gr. of the acetate to 1 fl. oz.

Dose, 10 to 60 m.—6 to 36 decimils.

Morphinæ Tartras.—Morphine Tartrate $(C_{17}H_{19}NO_3)_2,C_4H_6O_6,3H_2O$.

SOURCE.—May be obtained by the combination of morphine and tartaric acid.

CHARACTERS.—A white powder consisting of tufts of minute acicular crystals. *Solubility.*—1 in 11 of cold water, not in alcohol.

INCOMPATIBLES.—As morphine hydrochloride.

Dose, $\frac{1}{8}$ to $\frac{1}{2}$ gr.—8 to 30 milligrms.

Preparations.

1. Injectio Morphinæ Hypodermica. — Morphine tartrate, 2·5; water, 100. *Strength.*—2·5 per cent.; 2·5 grms. in 100 millilitres; 2·5 grs. in 110 ♏. NOTE.—It is one-half the strength of the corresponding preparation, B. P. 1898.

Dose, 5 to 10 ♏.—3 to 6 decimils—subcutaneously.

2. Liquor Morphinæ Tartratis. — Morphine tartrate, 1; alcohol (90 per cent.), 25; water, 100. *Strength.*—1 per cent., or 1 gr. in 110 ♏, 1 grm. in 100 millilitres, or about $4\frac{1}{2}$ gr. of the tartrate to 1 fl. oz.

Dose, 10 to 60 ♏.—6 to 36 decimils.

ACTION.

The action and uses of opium in man are due almost entirely to its morphine, and therefore they may be studied together. For Codeine, *see* p. 378.

External.—Opium probably has no action when applied to the unbroken skin, but it has been said to be slightly anodyne. It can be absorbed from and relieve the pain of raw surfaces.

Internal.—*Alimentary canal.*—As far as we know opium diminishes all the secretions of the body except the sweat. The mouth consequently becomes dry, and the patient feels thirsty, but after a small dose not markedly so. This effect is partly due to the direct action of the opium on the mouth, but to a less extent to its influence exerted after it has been absorbed. In the stomach and intestine, by the same double action, the secretion of the gastric and intestinal juices is diminished. The drug also paralyses

the peristaltic movements of the stomach and intestines. This is due to its action on the nervous or muscular structures in the wall of the intestine itself. The result of the diminution of secretion and peristalsis is that opium appeases hunger, often causes indigestion, almost always gives rise to constipation, and if vomiting or diarrhœa is present it may prevent it. These actions are also in part due to its general sedative influence on the nervous system. If pain exists in the abdomen or elsewhere opium is a powerful anodyne. Most of it is absorbed, but rather slowly. If injected subcutaneously it is excreted into the stomach and bowels. With some persons it causes vomiting, often most marked many hours after the drug has been taken. Whether the biliary secretion is diminished is not known, the pancreatic secretion is lessened. Opium is mostly excreted in the fæces.

Blood.—Morphine for the most part circulates in the blood as such, and is excreted almost entirely by the intestinal mucous membrane, and very slightly by the kidneys, but a small part of it is destroyed in the body, probably in the liver; if morphine is taken habitually, the amount so destroyed gradually increases, and this explains why some persons can take such large quantities. The fate of the other alkaloids is not known, nor are we aware of any direct action of any of the constituents of opium on the blood itself.

Circulation.—In an ordinary healthy man small doses of opium hardly affect the heart or vessels, but with those who are ill morphine often makes the pulse slow. Patients rarely die from the direct effect of opium on the heart and its nervous apparatus, this being much less important than the influence on respiration, and some of the cardiac depression may be secondary to asphyxia.

The vaso-motor centres are slightly depressed by moderate doses, hence the vessels, particularly those

of the skin, dilate; with large doses the depression is considerable.

Respiration.—Opium is a direct poison to the respiratory centre. Breathing therefore becomes slow, less air is taken in at each inspiration, and death takes place from asphyxia. The secretion of bronchial mucus is decreased.

Nervous system.—Brain.—In a few people the higher faculties are at first slightly excited by small doses with but little incoordination. The intellectual power and mental vigour appear increased, and the drug is taken by some persons to enable them to do their mental work. Usually, however, the excitation does not affect the mind evenly; generally the imagination is powerfully and pleasantly excited, much more so than the faculties of reason and judgment, which are a little dulled. The expression on the face is one of happiness and comfort, and this corresponds with the condition of mind, which is in a state of peace, calm, and happiness. This is soon succeeded by sleep, which is accompanied by pleasant dreams, generally of an impossible nature. With some persons, however, the sleep is quite dreamless. This, which is the beginning of the depression of the highest centres, is soon followed by depression of the others, the higher being influenced before the lower, so that soon the sleeper does not respond to any sound, light, or cutaneous stimulation, nor does he feel pain. It is this last fact that makes the drug so invaluable, especially as the quantity of morphine necessary to relieve pain is often insufficient to cause much general depression. If a large or even moderate amount is given, generally there is no primary excitement, and then the first symptom that opium has been taken is drowsiness. On waking from sleep induced by opium some persons feel quite well, but usually there is a little languor, headache, and

nausea. Opium eaters take it for its stimulant effect. It is given medicinally as a hypnotic and anodyne. The pupil is contracted; this is due to the effect of the drug on the pupillary centre in the floor of the aqueduct of Sylvius. In man, just as the stimulation of the intellectual centres is brief, so is that of the cerebral motor centres—in fact, it is often difficult to detect any evidence of it. Their subsequent depression is never so marked as that of the intellectual faculties; for although there is languor and muscular weakness, and the patient always lies down, yet he can be walked about if he is supported. Vomiting is occasionally caused by transient irritation of the vomiting centre, but soon this is depressed, and therefore emetics do not act well in cases of opium poisoning.

The motor cells of the spinal cord are at first slightly stimulated, and consequently reflex excitability is exaggerated; but they are soon depressed, and it is difficult to obtain reflex movements.

The excitability of motor and sensory nerves is unaltered except that in the later stages of opium poisoning by enormous doses it is depressed, that of the sensory before the motor. The muscles remain irritable to the last.

Opium, in its action on the nervous system, illustrates the common fact that functions at first stimulated by a drug are usually subsequently paralysed by it (*see* p. 109); and it affords an excellent example of the law of dissolution, for higher functions, such as the intellectual and imaginative, are first affected; motion is then disordered; next the pupillary centre, and then the medullary centres for respiration and cardiac action are implicated. The spinal cord is influenced to a less degree, the nerves very slightly, and the muscles not at all.

In man the peculiarities of the action of morphine are the slightness of the stage of stimulation,

its predominating influence on the higher mental functions, and the slight affection of the motor and the vaso-motor centres, the cord, the nerves, and the muscles. In frogs morphine produces violent convulsions, because its predominating action is to stimulate the spinal cord. Birds are only affected by large doses, which produce coma. Mammals are for the most part affected in the same way as man, except that the first or excitement stage is more marked; hence with many mammals, especially cats, morphine is a violent convulsant; dogs and rabbits require large doses to produce symptoms.

Kidneys.—Opium has but little effect on the urinary flow. Morphine is excreted by the bowel, it is only after large doses that traces occur in the urine, some of it is decomposed in the body, for oxydimorphine has been found in the urine of those taking morphine.

Skin.—Opium is a mild diaphoretic. It may cause itching.

Metabolism.—If the person taking it has glycosuria, the amount of sugar he passes in the urine is frequently diminished. General metabolism is slightly decreased also, for the amounts of nitrogen and carbonic acid excreted and oxygen absorbed are lessened.

Temperature.—Large doses depress this, probably from the effect of the drug on the thermogenetic nerve centres.

Persistent use of large doses decreases the secretion of milk and the menstrual discharge. Morphine is excreted by the milk, and so may affect the child.

Peculiarities.—There are few drugs which have such different effects upon different people. The above description states the manner in which most human beings are affected by opium, but in some the stage of excitation is very evident, so that they become delirious and cannot sleep. In others, vomiting and

indigestion are very marked. Some of these peculiarities are due, no doubt, to the varying composition of opium. Children are easily poisoned by it, and therefore only small doses should be administered to them; women are more readily affected than men. Persons who take it habitually soon tolerate enormous quantities. It may produce an erythematous eruption on the skin.

Differences in action between opium and morphine.—(1) Morphine, being more readily absorbed, acts more quickly. It is especially suited for subcutaneous injection; given in this way it acts very rapidly. (2) Opium is more liable to upset the digestion and to cause constipation, but this last fact often makes it the more valuable in many abdominal diseases. (3) Opium is the better diaphoretic. (4) Morphine is more certain in its action as an anodyne and soporific; possibly this is because of the other powerful alkaloids in opium. (5) Opium is stated to act more powerfully in reducing the amount of sugar present in the urine in glycosuria.

THERAPEUTICS.

External.—Hot fomentations or poultices sprinkled with laudanum are often applied to painful parts, but probably it is the heat and not the opium which relieves the pain. Linimentum Opii rubbed into the skin diminishes the pain of chronic rheumatism and myalgia; probably in this case the friction is more efficacious than the opium. Locally applied to sores and ulcers, it may soothe the pain due to them. The ointment of galls and opium will often relieve the pain of piles and anal fissures, especially if a mild laxative is given by the mouth.

Internal.—*Stomach.*—Morphine is of great service for the pain of gastric ulcer, cancer, or even for simple painful dyspepsia. One of the official solutions

of morphine (15 ♏, 1 mil, doses) is preferable to opium, as that may aggravate the indigestion. They are frequently combined with preparations of bismuth, and taken immediately before or after meals. Many forms of vomiting are relieved by morphine, because it decreases pain, peristalsis, and excessive secretion.

Intestines.—Opium is invaluable for stopping many varieties of diarrhœa. If they will yield to any treatment, opium is most likely to be successful. Intestinal colic, being due to irregular excessive peristaltic action, is generally relieved by opium—and, indeed, so is abdominal pain of all sorts. If in acute inflammatory conditions of the peritoneum, as appendicitis or general peritonitis, no operation is anticipated, full doses of opium must be given, the object being so to paralyse the intestinal movements as to prevent the peritoneal surfaces rubbing against each other. It is much used after operations or wounds in the abdomen. Opium is preferable to morphine for abdominal cases; if given it must be boldly pushed in severe cases, the patient being kept just drowsy with slightly contracted pupils, and it often does not matter if the bowels are not open for a week. It must be remembered that it masks symptoms, and must therefore not be given until the diagnosis and treatment have been formulated.

Heart.—Much skill is required to give opium properly in heart disease. The hypodermic injection of morphine is, on the whole, to be preferred to opium. The great indication for it is when cardiac pain and distress keep the patient awake. Often it acts like a charm, a quiet refreshing sleep being the result of a single injection. It is a feeble cardiac depressant, but we have to set against this the exhaustion of pain and insomnia. Still, if the patient is very ill, these two factors must be carefully balanced. It likewise often relieves the pain of aneurysm and

intra-thoracic growths. Its depressant effect may be to some extent counterbalanced by combining atropine with morphine.

Vessels.—Opium is a good hæmostatic as it quiets involuntary movements. It is probably efficient after absorption, but its great value is in gastric and intestinal hæmorrhage, when it acts partly by stopping peristaltic movements. An excellent form in which to give it is the Pilula Plumbi cum Opio. It is also very useful in hæmoptysis, for it acts as a hæmostatic by relieving the cough.

Respiration.—It will be remembered that opium depresses the respiratory centre; therefore it, by diminishing the activity of the centre for the reflex act of coughing, will often alleviate this distressing symptom, but it is only justifiable to give it when the irritation which reflexly sets up a cough is irremovable, as in intra-thoracic growth or aneurysm, or when there is little or no lividity and yet the cough is violent, as is often the case in pleurisy, and to a less extent in phthisis. The liability to lividity and asphyxia in many diseases attended with cough must never be forgotten. Thus opium is quite inadmissible in the last stages of bronchitis and pneumonia, and, as a rule, in even the earlier stages of bronchitis other means of relieving the cough should be tried first; and if opium is given, it must be administered with caution and judgment. But in pneumonia without lividity it is very useful, lessening cough and pain and promoting sleep. A "linctus opiatus," a favourite remedy, is often given at night when a cough keeps the patient awake. It may consist of tincture of opium, 2 ♏ (12 centimils); dilute sulphuric acid, 2 ♏ (12 centimils); treacle, 30 ♏ (2 mils); water to 1 fl. dr. (4 mils). The object of the treacle is to soothe the pharynx locally. Opium must also be given cautiously for asthma, as there is in this disease a great liability to the growth of a permanent opium habit. An insufflation of $\frac{1}{2}$ gr. (30

milligrms.) of acetate of morphine with 5 gr. (3 decigrms.) of starch is of great use when blown on to a larynx painful from organic disease. A grain of boric acid or a grain of iodoform is often added to each insufflation.

Nervous system.—Brain.—It is in its action on this organ that the marvellous value of opium is seen, its great function being to relieve pain and to produce sleep when that is prevented by pain. For these purposes it is best given hypodermically as morphine, for that acts more quickly, more certainly, and is less liable to produce indigestion and excitement than opium. Many like to inject a solution containing $\frac{1}{50}$ gr. (1·25 milligrm.) of atropine sulphate to each $\frac{1}{2}$ gr. (30 milligrms.) of morphine salt, for by so doing the liability of morphine to upset the stomach and bowels is diminished, and its efficacy as an anodyne is not sensibly lessened. It would be a long list to give all the diseases the pain of which can be relieved by morphine; cancer and fractures are typical instances. Morphine is very valuable for the insomnia of acute diseases; but it should never be prescribed for habitual sleeplessness, for fear the patient should contract the habit of opium taking—unless the disease causing the insomnia is incurable and will not last long, when the use of opium is quite justified. It should be given cautiously in gout, for that is often accompanied by granular kidneys; and not for hysteria, as often it does not relieve hysterical pains, and an opium habit may be formed. It is especially useful in renal and biliary colic, and for the after-pains of a confinement. In these cases it relieves the pain partly from its power as an anodyne, and also because by its paralysing effect on unstriped muscle it relaxes the muscular contraction. This property also makes it valuable in some cases of spasmodic stricture of the urethra. It may be given as a sedative in delirium

tremens and some forms of mania, but often such large doses are required that its use is not justifiable. Patients suffering great pain can take enormous doses without any symptoms of poisoning.

Spinal cord.—Its use for the pains of locomotor ataxy and for convulsive diseases is to be deprecated, as the morphia habit is easily formed.

Kidneys.—There are several cases recorded in which persons suffering from Bright's disease have been killed by quite small doses of opium. But it often so markedly relieves uræmic dyspnœa, uræmic insomnia, the cardiac dyspnœa which may complicate Bright's disease, and even uræmic convulsions, that it may be justifiable to inject $\frac{1}{6}$ of a grain (12 milligrms.) of a salt of morphine subcutaneously into a patient suffering from one of these conditions and run the slight risk there is of poisoning him. But it is clear that this treatment must be adopted very cautiously.

Skin.—Combined with ipecacuanha as Dover's powder, opium is commonly given as a mild diaphoretic in cases of slight inflammatory disorder, such as a common cold.

Metabolism.—Opium is administered to persons suffering from diabetes, and the amount of sugar in the urine often certainly diminishes and the patient's general health improves. Opium can, in the opinion of many, control all varieties of inflammation; therefore it is given for a cold in the head, for cystitis, pleurisy, &c. Occasionally persons taking opium suffer from retention of urine. We have indicated the occasions on which opium and morphine are respectively preferable.

Toxicology.

Acute poisoning.—There may be slight preliminary excitability, but soon drowsiness sets in; this is followed by incapacity for exertion, sleep, and finally deep coma. The pupils are

minutely contracted. At first the patient can be roused, but soon no stimulation will do this. Reflex action is abolished. The skin is cold, the face and lips are livid, and towards the end bathed in sweat. The pulse is weak and slow. The respiration becomes slower and more irregular, at last it is stertorous, and the patient dies from asphyxia.

Diagnosis of poisoning by opium.—**(1)** *From alcoholic poisoning.*—Often very difficult, especially if, as commonly happens, the man poisoned with opium has taken alcohol or had it given him. The pupils are more contracted in opium poisoning. The patient is more easily roused in alcohol poisoning. Examine the urine for morphine and alcohol. Get a careful history. **(2)** *From cerebral hæmorrhage.*—If this is in the pons Varolii the pupils may be very contracted and the diagnosis difficult, but look carefully for local paralyses. Usually cerebral hæmorrhage takes place into the internal capsule, and then the face and tho limbs on the opposite side are paralysed. If the hæmorrhage is a small one, and especially if it is in the pons, the temperature may be raised; if it is a very large one the temperature falls for the first few hours, but may rise subsequently. If the pupils are unequal the case is one of cerebral hæmorrhage. **(3)** *From carbolic acid poisoning,* in which there may be coma and contracted pupils. The acid produces white patches in the mouth, and the odour is characteristic. **(4)** *From chloroform and ether poisoning* by the odour of the breath and of the vomited matters. **(5)** *From uræmia* by the signs of Bright's disease, especially albuminuria. **(6)** *From diabetic coma* by the smell of the breath and the glycosuria. **(7)** *From the comatose stage of an epileptic fit* by the history, the dilatation of the pupils, and the fact that the lividity does not deepen. **(8)** *From the same stage of a fit in general paralysis* of the insane and other nervous diseases by the same symptoms.

Post mortem.—The appearances after death from opium poisoning are those always found after fatal asphyxia.

Treatment.—Wash out the stomach at half-hour intervals with Liquor Potassii Permanganatis (which decomposes morphine) diluted with three times the quantity of warm water, leaving about 5 fl. oz. in the stomach. Give prompt emetics (p. 145), as apomorphine subcutaneously. Always rouse the patient by walking him about, flapping him with a towel, pinching him, applying the faradic current, and putting ammonia to the nose; a pint of strong coffee should be injected into the rectum, $\frac{1}{20}$ gr. atropine sulphate given subcu-

taneously, or 30 ♏ of tincture of belladonna by the mouth repeated every quarter of an hour. If the breathing is very difficult, artificial respiration should be employed. Oxygen or amyl nitrite inhalations may be used. The treatment must be kept up for several hours if necessary.

Chronic Morphine poisoning.—As many persons administer the drug subcutaneously to themselves, chronic poisoning is very common. The symptoms are that the patient loses all sense of right and wrong, he will lie and thieve in the most degrading way, especially if his desire is to obtain the drug, and absolutely no statement that he makes can be trusted. He neglects his work, and lets his business go to ruin. He wastes and becomes anæmic, he suffers from loss of appetite, indigestion, dry mouth, sluggish bowels, and a foul tongue. The nails are brittle, the skin dry, the hair turns grey early, and falls out. There is sexual impotence, no erections take place, no semen is secreted; there is amenorrhœa, and the flow of milk is stopped, but there is polyuria. The pupils are small, and loss of muscular power, slight ataxy and tremor are present in severe cases. The arms or other parts are scarred with marks of the syringe, and 20 grains of morphine a day are sometimes taken.

The patient must be isolated and carefully watched to see that he gets no morphine (he often eludes or bribes his nurse); it should be diminished gradually, so that at the end of a fortnight he is taking none. If it is stopped suddenly there may be serious collapse and wild delirium. Relapses are very common, and a complete cure after a relapse is very rare.

Antagonism.

Atropine.—Atropine (alkaloid of belladonna) is an antidote to morphine, because it powerfully stimulates the respiratory centre. It also stimulates the cerebral convolutions and intestinal peristalsis, both depressed by morphine. It appears to be antagonistic to opium in other particulars, but is not really so. Thus, although it prevents perspiration and dilates the pupil, these effects are due to action on the peripheral nerve terminations, while morphine produces contrary results by acting on the central nervous system. Still it has been found that some of the undesirable effects that may follow the subcutaneous injection of morphine, such as indigestion, constipation, and cardiac depression, may be avoided if $\frac{1}{150}$ to $\frac{1}{100}$ gr. of atropine sulphate is injected at the same time.

Papaveretum. *Synonyms.*—Omnopon, Panopton (Not official).

A solution of the total alkaloids of opium as hydrochlorides and freed from meconic acids, gums, and resins.

COMPOSITION.—Morphine, 52 per cent.; narcotine, 20 per cent.; codeine, 2 per cent.; papaverine, 2·5 per cent.; thebaine, 1 per cent.; narceine, 1–2 per cent.; other alkaloids, 4 per cent.; water, 8 per cent.; hydrochloric acid, 9 per cent.

It is grey powder. Readily soluble in water.

Dose, $\frac{1}{6}$ to $\frac{1}{2}$ gr.—10 to 30 milligrms.—by mouth; **$\frac{1}{6}$ to $\frac{1}{3}$ gr.—10 to 20 milligrms.**—subcutaneously.

1 gr. papaveretum corresponds to 5 gr. opium.

Papaveretum is less toxic than morphine, and especially depresses the respiratory centre less; so it is of considerable use to stop purposeless coughing. It is less effective in diminishing peristalsis, and therefore upsets digestion less. It has no disadvantages to counterbalance these advantages.

Codeina.—Codeine. $C_{18}H_{21}NO_3,H_2O$.

SOURCE.—An alkaloid obtained from opium or morphine.

CHARACTERS.—Nearly colourless trimetric crystals. *Solubility.*—1 in 80 of cold water, 1 in 24 of boiling water, 1 in 2 of alcohol (90 per cent.), 1 in 2 of chloroform.

Dose, $\frac{1}{4}$ to 1 gr.—16 to 60 milligrms.

Codeinæ Phosphas. — Codeine Phosphate. $C_{18}H_{21}NO_3,H_3PO_4,2H_2O$.

CHARACTERS.—White crystals, slightly bitter. *Solubility.*—1 in 3·5 of water.

Dose, $\frac{1}{4}$ to 1 gr.—16 to 60 milligrms.

Preparation.

Syrupus Codeinæ Phosphatis.—Codeine phosphate, 1; distilled water, 3; syrup, to produce 200. *Strength.*—10 millilitres contain 0·05 grm. of codeine phosphate; 1 fl. dr. contains 0·27 gr.

Dose, $\frac{1}{2}$ to 2 fl. dr.—2 to 8 mils.

ACTION AND THERAPEUTICS.

It may produce tremors because it excites the cord more, and depresses the higher faculties and respiratory centre less, than morphine, and in man its physiological action is in all respects much less

than that of morphine. It often relieves the hacking cough of phthisis, and for this the official syrup of the phosphate is very useful. It is also used for cases of ovarian pain, and to diminish the glycosuria in diabetes; but it is doubtful whether it does this more effectually than opium. For diabetes it is usually given as a pill. The phosphate has the advantage of being much more soluble than codeine.

Thebaine (Not official) produces powerful convulsions by its action on the cord. Its subsequent depressant action is very slight.

Anarcotine (Not official). This is also known as Narcotine, which is a bad name, for the drug does not cause sleep. It is of use in ague, and it is the chief constituent of Indian opium.

Apomorphinæ Hydrochloridum.—Apomorphine Hydrochloride. $(C_{17}H_{17}NO_2,HCl)_2,H_2O$.

SOURCE.—It is the hydrochloride of an alkaloid obtained from morphine. The morphine loses one molecule of water.

CHARACTERS.—Small greyish-white, shining needles, turning green on exposure to light and air; faintly acid. *Solubility.*—1 in 60 of water, 1 in 50 of alcohol (90 per cent.).

Dose, $\frac{1}{20}$ to $\frac{1}{10}$ gr.—3 to 6 milligrms.—hypodermically, **$\frac{1}{10}$ to $\frac{1}{4}$ gr.—6 to 16 milligrms.**—by the mouth.

Preparation.

Injectio Apomorphinæ Hypodermica. — Apomorphine Hydrochloride, 1; diluted hydrochloric acid, 1; distilled water, 100. *Strength.*—1 per cent., 1 grm. in 100 millilitres or 1 gr. in 110 ♏. Must be freshly prepared, as it does not keep.

Dose, 5 to 10 m.—3 to 6 decimils.—hypodermically.

ACTION.

External.—None.

Internal.—*Gastro-intestinal tract.*—Apomorphine is the most powerful emetic we possess. It does not act locally on the stomach, but solely on the vomiting centre in the medulla. It is therefore an indirect

emetic. This is shown by the fact that when the drug is injected subcutaneously it produces violent vomiting if the vessels are so tied that none can reach the stomach, but not if they are so tied that it cannot reach the medulla.

Circulation.—Therapeutic doses have no effect beyond the depressing action which may be attributed to the vomiting. Large doses cause a rise in the rate of the pulse, probably from stimulation of the accelerator nerves, and with fatal doses the pulse-rate falls, because the drug directly paralyses the cardiac muscle.

Respiration.—This is at first stimulated by the act of vomiting. The effect of poisonous doses is doubtful; probably they depress respiration. If the bronchial secretion is thick and viscid it is rendered more fluid by apomorphine.

Nervous system.—The first result of toxic doses is to cause delirium. Finally there is paralysis of the motor nerves, and consequently of the muscles.

Therapeutics.

Vomiting action.—The advantages of apomorphine over other emetics are that it is certain, prompt, and powerful; it can be given when emetics introduced directly into the stomach would not act, and it does not irritate the stomach. It is largely used in cases of poisoning. It is usually given hypodermically. As the pharmacopœial injection will not keep, it is advisable to use gelatin discs of apomorphine hydrochloride, which can be dissolved as required.

Expectorant action.—It is, when given by the mouth, a valuable expectorant for chronic bronchitis when we wish to diminish the viscidity of the expectoration. It may advantageously be combined with terebene suspended in mucilage, but the mixture is very nasty. The Syrupus Apomorphinæ

(B. P. C.), strength $\frac{1}{36}$ gr. to 1 fluid drachm (2 milligrms. to 4 mils), dose $\frac{1}{2}$ to 1 fluid drachm (2 to 4 mils), is a good preparation. The drug may also be given as a lozenge.

Diamorphinæ Hydrochloridum. — Diamorphine hydrochloride. $C_{21}H_{21}NO_5$, HCl,H_2O.

Synonyms.—Heroin hydrochloride, diacetyl-morphine hydrochloride, aceto-morphine hydrochloride.

SOURCE.—An alkaloid obtained by the action of acetic anhydride on morphine.

CHARACTERS.—A white, bitter, crystalline powder.

Dose, $\frac{1}{25}$ to $\frac{1}{8}$ gr.—2·5 to 8 milligrms.

ACTION AND THERAPEUTICS.

This drug is used to allay cough, especially incessant cough, without much expectoration, and for this purpose it is one of the best drugs we possess. A good formula is diamorphine hydrochloride $\frac{1}{20}$ gr. (3 milligrms.), with a drachm of each of syrup of codeine and syrup of Virginia prune, and another which is very pleasant contains terpin hydrate $\frac{1}{2}$ gr. (30 milligrms.), diamorphine hydrochloride $\frac{1}{48}$ gr. (1·6 milligrm.) to one drachm (4 mils) of the syrup of Virginia prune. It is known as Elixir Terperoin. The Elixir Acetomorphinæ et Pini Co. (B. P. C.), dose $\frac{1}{2}$ to 1 fl. dr. (2 to 4 mils), is another good preparation. Diamorphine hydrochloride is perhaps most used in phthisis and asthma. It does not often produce the headache and other disagreeable effects which may follow morphine. A twelfth of a grain dissolved in water can be given every four hours by the mouth, or less subcutaneously. Sometimes it is given instead of morphine to produce sleep. It prolongs inspiration, increases the depth of respiration, and depresses the respiratory centre; large doses may produce dangerous depression, and in some animals it induces convulsions. Dionin or ethyl morphine,

usually met with as a hydrochloride, has the same action as diamorphine, but is less powerful, and occupies an intermediate position between diamorphine and codein. All three depress the respiratory centre less than morphine.

Cotarnine Hydrochloride. $C_{12}H_{16}NO_4Cl$. (Not official.) *Synonym.*—Stypticin.

Prepared by oxidizing narcotine. It occurs as primrose-coloured crystals, very soluble in water and alcohol. It is allied to hydrastinine, being methoxyl-hydrastinine.

Dose, ½ to 1 gr.—3 to 6 centigrms.—internally or hypodermically.

It is used to check hæmorrhage, especially uterine. Stypticin wool, gauze, bougies, and ointment are employed locally.

RED POPPY PETALS.

Rhœados Petala.—Red Poppy Petals. The fresh petals of *Papaver rhœas*.

Characters.—Scarlet, smooth and lustrous, with a smell of opium and a bitter taste.

Composition.—Red colouring matter, 40 per cent. This consists of papaveric and rhœadic acids. It is soluble in water. The petals contain no morphine, nor have they any narcotic properties.

Preparation.

Syrupus Rhœados.—Petals, 26; sugar, 72; alcohol (90 per cent.), 5; water to make 100. In hot countries the proportion of alcohol may be a little increased to prevent fermentation.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Action and Uses.

Poppy petals are only used as a colouring agent.

BELLADONNA.

Belladonnæ Folia.—Belladonna Leaves. The leaves, collected when the plant is in flower, and then dried, of *Atropa belladonna*. *Synonym.*—Deadly nightshade.

Characters.—Eight to twenty centimetres long, broadly ovate, acute, entire, glabrous or nearly so. The expressed juice or an infusion dropped into the eye, dilates the pupil.

Strength.—Belladonna leaves must yield not less than 0·30 per cent. of alkaloids. *Resembling belladonna leaves.*—Stramonium leaves, more wrinkled; hyoscyamus leaves, hairy.

Composition.—The chief constituents are—(1) *Atropine* (*see* p. 384). (2) *Hyoscyamine*, which is the same as daturine (*see* p. 396). These two alkaloids are optical isomers: Atropine is optically inactive; hyoscyamine is lævorotatory, but otherwise chemically identical with atropine. Hyoscyamine is usually the more abundant, but the proportion of the two alkaloids varies according to the specimen and the method of extraction employed.

Belladonnæ Radix.—Belladonna Root. The root of *Atropa belladonna*, collected in the autumn and dried.

Characters.—Cylindrical branched pieces entire or longitudinally split, 15 to 30 centimetres long, 10 to 20 millimetres thick. Externally pale greyish brown, wrinkled longitudinally. Fracture short. Internally the root is white and starchy, with no very evident radiate appearance. *Resembling belladonna root.*—Pyrethrum root, which is unbranched, and has a burning taste and a radiate fractured surface. Scammony root is larger.

Composition.—As of the leaves. Usually contains 0·4 to 0·5 per cent. of alkaloids, chiefly hyoscyamine.

Preparations.

1. **Extractum Belladonnæ Liquidum.**—Prepared by repeated percolation of the root with alcohol (90 per cent.) and water. *Standardized to contain* 0·75 *per cent. of the alkaloids of the root.*

2. **Extractum Belladonnæ Siccum.**—Prepared from the leaves by percolation with alcohol (70 per cent.). *Standardized to contain* 1 *per cent. of the alkaloids.*

This is Extractum Belladonnæ Alcoholicum, B. P. 1898.

Dose, $\frac{1}{4}$ to 1 gr.—16 to 60 milligrms.

3. **Emplastrum Belladonnæ.**—Liquid extract, 50; evaporate and add resin plaster, 137·5. *Strength.*—0·25 per cent. of the alkaloids, and is one-half the strength of Emplastrum Belladonnæ, B. P. 1898.

4. **Linimentum Belladonnæ.**—Liquid extract, 50; camphor, 5; water, 10; alcohol (90 per cent.), 100. *Strength.*—0·375 per cent. of alkaloids.

5. Tinctura Belladonnæ.—Belladonna leaves, dried and powdered, 1; alcohol (70 per cent.), 10. *Standardized to contain* 0·035 *per cent. of total alkaloids.* This tincture contains $\frac{7}{10}$ of the alkaloids contained in the Tincture of Belladonna, B. P. 1898.

Dose, 5 to 15 m.—3 to 10 decimils.

6. Unguentum Belladonnæ.—Liquid extract, 8, benzoated lard, 6; wool fat, 2. *Strength.*—0·6 per cent. of alkaloids.

In India benzoated suet should be used instead of benzoated lard.

7. Suppositoria Belladonnæ.—Liquid extract, 1·7 millilitres; oil of theobroma, q.s. to make twelve. *Strength.*—Each contains 0·001 grm. (about $\frac{1}{60}$ gr.) of the alkaloids.

Atropina.—Atropine. *Synonym.*—Atropia. $C_{17}H_{23}NO_3$.

SOURCE.—An alkaloid obtained from Atropa belladonna and other plants of the order Solanaceæ.

CHARACTERS.—Colourless acicular crystals. *Solubility.*—1 in 500 of cold, 1 in 58 of boiling water, 1 in 1 of chloroform, 1 in 3 of alcohol (90 per cent.), 1 in 30 of ether, 1 in 52 of glycerin, and 1 in 15 of oleic acid.

COMPOSITION.—It consists of the alkaloid tropine, which is both a nitrogenous base and an alcohol, combined as an ethereal salt with aromatic acid, tropic acid. Atropine is optically inactive hyoscyamine, containing lævohyoscyamine and dextrohyoscyamine in equal proportions.

INCOMPATIBLES.—Caustic alkalies decompose it.

Dose, $\frac{1}{200}$ to $\frac{1}{100}$ gr.—0·3 to 0·6 milligrm.

Preparation.

Unguentum Atropinæ.—Atropine, 2; oleic acid, 8; prepared lard, 90.

In India prepared suet should be employed instead of prepared lard.

Atropinæ Sulphas.—Atropine Sulphate. $(C_{17}H_{23}NO_3)_2H_2SO_4$.

SOURCE.—It may be obtained by neutralizing atropine with diluted sulphuric acid.

CHARACTERS.—Nearly colourless, crystalline substance. *Solubility.*—2 in 1 of water, solution neutral; 1 in 4 of alcohol (90 per cent.).

Dose, $\frac{1}{200}$ to $\frac{1}{100}$ gr.—0·3 to 0·6 milligrm.

Preparations.

1. Lamellæ Atropinæ.—Discs containing in each atropine sulphate, $\frac{1}{5000}$ gr. (0·013 milligrm.); gelatin and glycerin, $\frac{1}{50}$ gr. (1·3 milligrm.)

2. Liquor Atropinæ Sulphatis.—Atropine sulphate, 1; distilled water, 100. *Strength.*—1 per cent., or 1 gr. of the sulphate in 110 ℳ, 1 grm. in 100 millilitres.

Dose, ½ to 1 m.—3 to 6 centimils.

Action.

The actions of belladonna and atropine are the same.

External.—Atropine placed by itself upon the unbroken skin cannot be absorbed, but rubbed in with substances which are absorbed, such as alcohol, glycerin, or camphor, or applied to a broken surface, it paralyses the terminations of the sensory nerves, especially if pain is present. It is thus a local anæsthetic and an **anodyne**. These are its chief actions; but to a much less extent it locally paralyses the terminations of the motor nerves, first contracts and then dilates the vessels, and renders the secretions of the skin less active.

Internal.—*Gastro-intestinal tract.*—It will be convenient to describe the effects of belladonna on all secretions when speaking of its action on nerves, and we need not mention here its influence on the muscular coat of the intestine, for that is secondary to its action on the nervous system.

Blood.—Atropine is quickly absorbed, but does not affect the blood. Its main action is on the nervous system, and that must be considered in detail.

Secretory nerves.—The activity of the peripheral terminations of all the secretory nerves in the body is, as far as we know, depressed, so that the secretions of those glands, whose activity is essentially regulated by their nerve supply, are markedly dimi-

nished, while the secretions of other glands are little altered.

Mouth.—Even small doses of atropine make the mouth dry from lack of saliva and mucus. In health, secretion of submaxillary saliva always follows stimulation of the chorda tympani nerve, and, as is well known, this is due to the fact that this nerve is the secretory nerve for this gland, and not to any vascular dilatation. If atropine be given to an animal, stimulation of the chorda no longer causes an increased flow of saliva, however close to the gland the nerve is excited, the reason being that atropine has paralysed the terminal junctions of the chorda tympani (*see* p. 83). In the same way the terminations of the secretory nerves of the other salivary glands and the mucous glands are paralysed, and hence the mouth is dry, because normal impulses cannot reach the cells of the glands.

Stomach, pancreas, and intestines.—Atropine diminishes the secretions of these by paralysing secretory nerve terminals. It is not known if the bile is affected.

Sweat glands.—Atropine paralyses the terminations of the nerves in the sudoriparous glands. Thus the skin becomes dry. Likewise tears are lessened.

Kidneys.—Atropine has no direct effect on the secretion of urine.

Bronchial mucous membrane.—The secretion of bronchial and tracheal mucus, like that of the mouth, is diminished.

Mammary gland.—Belladonna is used to inhibit the secretion of active mammary glands, but experiments on animals have not shown that it has any great influence in this direction.

Sensory nerves.—It has already been mentioned that belladonna rubbed into the skin depresses the function of the terminations of the sensory nerves. It does the same when given by the mouth, but its

action on sensory nerves—that is to say, its anæsthetic and anodyne action—is very inferior to that on the secretory nerves, and is not powerful enough for atropine to relieve pain when given internally. It is only used as a local anodyne.

Voluntary muscles and their nerves.—Voluntary muscles are quite unaffected even by toxic doses of atropine; towards the end of a case of belladonna poisoning the motor nerves are slightly paralysed.

Involuntary muscles and their nerves.—If atropine in small doses is given to animals, it is observed that the bowels are relaxed, and vomiting takes place. On the other hand larger doses stop peristalsis. These results are almost certainly due to paralysis of some of the numerous nerve endings distributed to the stomach and intestines.

All involuntary nerve terminations, as those of the muscles of the bladder, ureters, urethra, vesiculæ seminales, uterus, and vagina, are paralysed like those in the intestinal muscles.

The eye and its nerves.—Atropine acts only on the terminations of the nerves in the involuntary muscles of the eye. If it be dropped into the eye or given by the mouth, the pupil dilates widely, and cannot be made to contract by stimulation of the third nerve. That this dilatation is not due to any marked action on the muscular fibres of the iris themselves is shown by the fact that the atropinized pupil will contract if the muscle itself be stimulated. Therefore it must be that the terminations of the third nerve in the iris are paralysed. The ending of this nerve in the ciliary muscle is affected in the same way, and consequently accommodation is paralysed. It is certain that this mydriasis and defective accommodation is in no part central, as is the contraction of the pupil produced by opium. So strong is the local action of belladonna, that if atropine be dropped into the recently excised eye the pupil will dilate.

When the third nerve is cut the pupil dilates, and if after this atropine be dropped into the eye it dilates still further. Thus atropine also stimulates the terminations of the sympathetic in the iris; but this action is comparatively slight, the chief result is the tonus of the radiating fibres causing dilatation because the nerve endings of the circular are paralysed by atropine. The intra-ocular tension is increased by large doses. There is, as a result of the paralysis of the ciliary muscle, disturbance of vision. Atropine does not act on the pupils of birds.

The heart and its nerves.—The main action of atropine is to paralyse the terminations of the vagus in the heart, and consequently the pulse is rendered more rapid, and cannot be slowed by strongly stimulating the vagus. If the rate of the heart has been lowered by muscarin, which can be shown to have a local stimulating influence on the terminations of the vagus in the heart, the application of atropine renders the heart quick again, the two drugs being, in their effect on the heart, exactly antagonistic. This quickening of the pulse from inhibition of the vagal cardiac terminal filaments is the chief action of atropine on the heart, but the following minor actions must be noticed. The vagus centre is also depressed, but to a much less extent. Before the pulse is quickened it is occasionally slowed for a short time by atropine; this is probably owing to a brief excitation of the vagus centre. Some authorities believe that part of the quickening of the pulse is due to a slight stimulation of the cardiac accelerator nerves, in the same way as we have seen that the sympathetic fibres in the iris are excited; but if the accelerator nerves are stimulated, this stimulation is quite subsidiary to the important paralysis of the vagal terminations. Although the pulse is quickened by belladonna, its force is not diminished. Toxic doses abolish the

function of the cardiac muscle, and the heart stops in diastole.

Vaso-motor system and its nerves.—After a considerable dose of belladonna the skin is flushed, and a scarlatiniform erythematous rash may be present in belladonna poisoning. It is thus obvious that such a dose of belladonna relaxes the peripheral vessels. The exact cause of this has not definitely been made out, but it is extremely probable that it is largely a peripheral action, quite harmonizing with the peripheral action we have seen atropine to have on the involuntary muscles of the intestines, eye, and heart; that is to say, the vaso-constrictor nerve-filaments supplying the arterioles are paralysed, and consequently the vessels dilate. The action of atropine on the medullary vaso-motor centre is quite unimportant even if it exists, but owing to the action on the terminations of the vagus in the heart causing increased rapidity of beat, the blood-pressure rises somewhat; subsequently it falls, the fall may be slightly due to the depression of the vaso-motor centre but chiefly to the peripheral action of belladonna on the vessels, causing their wide dilatation. Ultimately, when the heart itself is paralysed, the blood-pressure is very low.

Respiration and its nerves.—Here also belladonna paralyses peripheral nerve-filaments, in this case those of the vagus in the bronchial tubes. Both the afferent and efferent pulmonary vagal fibres are affected. The result is that the muscular coat of the bronchial tubes is relaxed, and that the secretions (the activity of the afferent fibres being depressed) do not irritate the nerves so much as before, and therefore cough is lessened. It will be remembered that the quantity of bronchial secretion is diminished. The respiratory centre is first stimulated, and so the respirations are quicker and deeper, then large doses paralyse them, and the breathing is

slow and shallow. The patient becomes asphyxiated, and this contributes to the result in a fatal case.

Temperature.—This is decidedly raised by toxic doses of belladonna (it may be four degrees Fahrenheit or more). This rise is independent of the blood-pressure and of the diminution of perspiration. It is said that heat-production is greatly exaggerated. The heat-loss is also increased, probably because the flushing of the skin leads to a greater loss by radiation.

Spinal cord.—Belladonna has little influence on the spinal cord in man, but it has a well-marked tetanizing effect in frogs. It is said slightly to increase and afterwards diminish general reflex excitability.

Cerebrum.—A considerable dose of belladonna causes delirium, showing that the higher centres are stimulated. Generally the stimulation takes place incoordinately. That it is powerful is indicated by the fact that in poisoning by belladonna the delirium will last for a long while. The subsequent quietude is not more than the exhaustion of the cerebrum from the continued delirium will explain. Belladonna rarely, if ever, produces genuine coma. Other symptoms that may be observed with large doses, and which are probably due to disorder of the brain, are visions, staggering gait, giddiness, and occasionally convulsions.

Elimination.—Atropine is eliminated entirely by the kidney.

It will be seen that the dominant action of belladonna is to depress the activity of the terminations of all varieties of nerves except those of voluntary nerves; speaking more accurately it paralyses the junctional substance between the nerve ending and the muscle or gland cell. In addition, it first stimulates and then depresses the cardiac and respiratory centres, and it is a deliriant.

Children may take considerable doses of belladonna without any symptoms of poisoning.

Pigeons and rodents are peculiarly insusceptible to it.

The action of atropine on secretion, the heart, and pupil is due to lævohyoscyamine, dextrohyoscyamine having little action on these; on the other hand, the action of atropine on the spinal cord of frogs is due to dextrohyoscyamine.

THERAPEUTICS.

External.—Belladonna is used externally to relieve all sorts of pain—for example, that of neuralgia, pleurodynia, and chronic osteo-arthritis. Chloroformum Belladonnæ, B. P. C. (the root is extracted with chloroform), diluted with a little olive oil, or the liniment is excellent for these purposes. Glycerinum Belladonnæ (B. P. C.) soothes the pain of acute inflammations. This, or the plaster, or the ointment, is much used to prevent the secretion of milk in women who do not for any reason nurse their infants, but it must be remembered that the plaster is sufficiently strong to produce erythema and general toxic symptoms in those especially susceptible. Pruritus and local sweating of various parts of the body, especially the feet, may sometimes be stopped by the frequent application of belladonna liniment. A lamella, or a solution of the same strength (atropine sulphate 4 gr. (25 centigrms.), boric acid 5 gr. (30 centigrms.), water 1 fl. oz., 30 mils), will dilate the pupil for ophthalmoscopic examination. Atropine is often used in ophthalmic practice to paralyse the movements of the iris and ciliary muscle, to break down adhesions, and to prevent the formation of contractions of the iris (*see* Homatropine, p. 394).

Internal.—*Alimentary canal.*—Atropine has occasionally been employed to check salivation, and

some use it to overcome constipation and colic. The extract is then given, and is commonly combined with some purgative in a pill. Dry extract of belladonna may be ordered with opium as a pill for patients suffering from appendicitis or peritonitis, if operation is inadvisable; as it is given several times a day, a large amount is taken, and this, as already explained, paralyses intestinal movements, and so aids the opium.

Skin.—Atropine sulphate ($\frac{1}{100}$ gr., 0·6 milligrm.) injected subcutaneously, or one or two minims of the Liquor Atropinæ Sulphatis by the mouth, will sometimes arrest sweating, and this treatment may succeed with the night sweats of phthisis.

Circulation.—There are many cases of heart disease in which belladonna may advantageously be combined with other drugs. Whenever we wish to empty the ventricle completely it is useful, for it will be remembered that it increases the rapidity of the heart without diminishing the force. But its greatest value is to remove cardiac pain and distress, which it often does most effectually. It may be conveniently applied as a plaster over the cardiac region, or it may be given internally, usually as the tincture. A subcutaneous injection of atropine is useful for chloroform poisoning.

Respiration.—As belladonna relaxes the muscular coat of the bronchial tubes it is of great value in spasmodic affections of the respiratory passages. Thus, of all the numerous drugs that have been given for whooping-cough, it is one of the best. It is also very useful in asthma, and in bronchitis with asthma-like paroxysms; in the last-named disease its powerful stimulation of the respiratory centre and its capability of diminishing the secretion will, in properly chosen cases, render it particularly valuable. It is generally given as the tincture, and combined with other drugs. A useful linctus contains tincture of bella-

donna 3 ♏ (18 centimils), vinegar of squill 5 ♏ (30 centimils), syrup of tolu 10 ♏ (6 decimils), glycerin to 1 fl. dr. (4 mils).

Genito-urinary diseases.—Belladonna is one of the favourite remedies for the nocturnal incontinence of children, and it occasionally overcomes this trouble in adults when it is not due to organic disease. Its power of relieving the spasm of involuntary muscle is well shown in the effectual manner in which the very painful vesical spasm which accompanies calculus, cystitis, and prostatitis may be benefited by it. It may be given internally, or applied as a plaster to the perinæum.

Atropine combined with strychnine has been injected subcutaneously to diminish the craving for alcohol. Atropine has also been tried in many nervous diseases, but without any good results.

Toxicology.

If a person takes a moderate dose of belladonna he soon experiences dryness of the mouth and throat, and as the food, therefore, cannot be properly lubricated, there is difficulty of swallowing; the pulse may at first be a little slower than usual. The pupil is dilated; accommodation is defective, and vision confused. The skin feels dry. If the dose has been a large one, these symptoms all come on quickly; the conjunctivæ and face, and perhaps other parts of the skin, are flushed, and the rate of the pulse is greatly increased, it may even be doubled. The patient staggers, feels giddy, and reels when he walks; the throat soon becomes very hot, the skin still more flushed, the eyelids swell, and there may be a uniform erythematous rash. The temperature is often raised, the respirations are slow and deep. The pupils are very widely dilated. By this time the patient is quite delirious. There may be purging, but this is not common; and sometimes he complains of a frequent desire to micturate, although he is unable to pass any urine. Death takes place from cardiac failure combined with asphyxia. *Post mortem.*—The organs are all in a state of venous congestion, which is due to the asphyxia. If recovery takes place the patient may have no recollection of his illness.

Treatment.—Give emetics (p. 145) or wash out the stomach.

Stimulants and pilocarpine or morphine subcutaneously. Employ artificial respiration and hot bottles and give strong coffee *per rectum*.

ANTAGONISM.

The antagonism between atropine and morphine has already been discussed (*see* p. 377). It is clear that as *pilocarpine* stimulates the terminations of the secretory nerves in the salivary and sweat glands, and also excites the terminations of the third nerve in the iris and ciliary muscle, it is a diaphoretic, a sialogogue, and a myotic, and is in these respects antagonistic to atropine. *Physostigmine* also causes contraction of the pupil and spasm of the ciliary muscle by stimulation of the terminations of the third nerve, and it depresses the respiratory centre almost from the beginning. In these points it is an antagonist to atropine.

Homatropinæ Hydrobromidum.—Homatropine Hydrobromide. $C_{16}H_{21}NO_3HBr$.

SOURCE.—It is the hydrobromide of an alkaloid prepared from tropine.

CHARACTERS.—A white crystalline powder or aggregation of minute trimetric crystals. *Solubility.*—1 in 6 of water, 1 in 18 of alcohol (90 per cent.).

Dose, $\frac{1}{64}$ to $\frac{1}{32}$ gr.—1 to 2 milligrms.

Preparation.

Lamellæ Homatropinæ.—Discs of gelatin and glycerin each weighing $\frac{1}{32}$ gr. (2·1 milligrms.) and containing $\frac{1}{100}$ gr. (0·65 milligrms.) of homatropine hydrobromide.

ACTION AND THERAPEUTICS.

Homatropine has an action exactly similar, as far as we know, to that of atropine. It is only used to dilate the pupil in ophthalmic practice, the advantage over atropine being that the dilatation produced by homatropine passes off in a quarter of the time. It may be applied either as a solution (4 gr. of the hydrobromide to 1 fl. oz. of distilled water) or as the lamella. Sometimes a solution in castor oil is used,

for it is less likely to be washed out by the tears, but it may be rather irritating.

STRAMONIUM.

Stramonii Folia.—The dried leaves of *Datura stramonium*.

CHARACTERS.—Ovate, petiolate, 10 to 15 centimetres long, dark green, wrinkled, unequal at base, margin sinuate dentate, and apex acuminate. Odour slightly narcotic. Taste saline and bitter. *Resembling stramonium leaves.* — Belladonna leaves, less wrinkled; hyoscyamus leaves, hairy.

COMPOSITION.—Chiefly hyoscyamine with a little atropine, but the proportion of alkaloids is inconstant. The total alkaloids are sometimes called daturine.

Preparation.

Tinctura Stramonii.—Stramonium leaves, 2; alcohol (45 per cent.), 10. Percolate.

Dose, 5 to 15 m.—3 to 10 decimas.

ACTION.

The physiological action of stramonium is almost the same as that of belladonna; the differences being that stramonium relaxes the muscular coat of the bronchial tubes more powerfully than belladonna, it may cause the heart to be a little irregular, and is generally thought to be more active than belladonna.

THERAPEUTICS.

There is no reason why stramonium should not be employed for the same purposes as belladonna, but it is rarely used, except in cases of asthma to relieve the spasm of the bronchial tubes. For this it is very valuable. Cigarettes of the leaves may be smoked, or the drug may be given internally. The following powder, which gives off dense fumes if burnt, affords great relief for asthma:—leaves

of Datura Stramonium and of Datura Tatula, Cannabis Indica, and Lobelia Inflata, all in powder, and of each 360 gr. (24 grms.); nitre in powder, 1 oz. (32 grms.); *eucalyptus oil*, 30 ♏ (2 mils). Mix thoroughly. Himrod's, Bliss's, and other "cures" for asthma are of a similar composition.

DATURA LEAVES.

Daturæ Folia.—The dried leaves of *Datura fastuosa* and of *Datura metel.*

CHARACTERS.—Ovate, acuminate, with long petioles and sinuate dentate margins. The larger are about 20 centimetres long and 13 centimetres wide. Brown or yellowish green. Characteristic odour and bitter taste.

ACTION AND THERAPEUTICS.

These leaves have the same action, and may be used for the same purposes, as those of *Datura stramonium.* Preparations of them may also be used instead of belladonna. Employed chiefly in India and the East.

DATURA SEEDS.

Daturæ Semina.—The dried seeds of *Datura fastuosa.*

CHARACTERS.—Yellowish brown. Wedge-shaped; rounded, thickened, furrowed, wavy margins, strongly compressed laterally, about 5 millimetres broad and 1 millimetre thick. The testa is finely pitted and reticulated.

Preparation.

Tinctura Daturæ Seminum.—1 in 4 of alcohol (60 per cent.). Percolate.

Dose, 5 to 15 m.—3 to 10 decimils.

ACTION AND THERAPEUTICS.

These seeds have the same action as those of *Datura stramonium.* They are employed chiefly in India and the East.

HENBANE.

Hyoscyami Folia.—Hyoscyamus Leaves. *Synonym.*—Henbane Leaves. The leaves of *Hyoscyamus niger*. Collected from flowering plants and dried.

Characters.—Varying in length up to 25 centimetres, with or without stalks, alternate, exstipulate, triangular-ovate or ovate oblong, pale green, glandular-hairy, particularly underneath. Branches subcylindrical, and also glandular-hairy. Odour strong, heavy when fresh. Taste bitter, slightly acrid. The juice dropped in the eye dilates the pupil.

Composition.—The chief constituents are—(1) *Hyoscyamine*, $C_{17}H_{23}NO_3$, an alkaloid. Characters: snow-white masses of minute crystals. *Solubility.*—1 in 120 of water, freely in alcohol. It is also contained in belladonna, stramonium, and many other plants of the Natural Order *Solanaceæ*. It, like atropine, with which it is isomeric, consists of tropic acid and tropine. Lævohyoscyamine and dextrohyoscyamine both exist. There is in commerce an amorphous impure hyoscyamine, which is a dark brown fluid having a disagreeable odour. As it is much cheaper than the crystalline alkaloid it is often used. Probably it contains no hyoscyamine, but only hyoscine. (2) *Hyoscine.* $C_{17}H_{21}NO_4H_2O$. Characters: a white crystalline alkaloid. It is isomeric with a powerful mydriatic alkaloid, atroscine which consists of oscine and atropic acid. (3) A poisonous oil.

Incompatibles.—Vegetable acids, silver nitrate, lead acetate, alkalies.

Preparations.

1. Extractum Hyoscyami.—An alcoholic (70 per cent.) extract.

Standardized to contain 0·3 *per cent. of the alkaloids of hyoscyamus leaves.*

This is Extractum Hyoscyami Viride, B. P. 1898.

Dose, 2 to 8 gr.—12 to 50 centigrms.

2. Pilula Colocynthidis et Hyoscyami.—Extract of hyoscyamus, 1; compound pill of colocynth, 2; water, q.s. (*see* Colocynth).

Dose, 4 to 8 gr.—25 to 50 centigrms.

3. Tinctura Hyoscyami.—Hyoscyamus leaves, 1; alcohol (70 per cent.), 10. Percolate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Hyoscinæ Hydrobromidum.—Hyoscine hydrobromide. $C_{17}H_{21}NO_4,HBr,3H_2O$. *Synonym.*—Scopolamine hydrobromide. The hydrobromide of an alkaloid, hyoscine or scopolamine, obtained from various plants of the natural order Solanaceæ.

CHARACTERS.—Colourless, small, transparent, rhombic crystals, slightly bitter taste. *Solubility.*—1 in 4 cold water; 1 in 13 alcohol (90 per cent.).

Dose, $\frac{1}{200}$ to $\frac{1}{100}$ gr.—0·3 to 0·6 milligrm.—usually given subcutaneously.

Hyoscyaminæ Sulphas. — Hyoscyamine Sulphate. $(C_{17}H_{23}NO_3)_2H_2SO_4,2H_2O$. The sulphate of an alkaloid, hyoscyamine, obtained from various plants belonging to the natural order Solanaceæ.

CHARACTERS.—A crystalline, deliquescent, odourless, bitter powder. *Solubility.*—2 in 1 water; 1 in $4\frac{1}{2}$ alcohol (90 per cent.).

Dose, $\frac{1}{200}$ to $\frac{1}{100}$ gr.—0·3 to 0·6 milligrm.

Both hyoscine and hyoscyamine salts are usually given subcutaneously. Convenient discs of both of them, to be dissolved before use, are prepared.

ACTION.

That the action of hyoscyamus is almost identical with that of belladonna and stramonium is not surprising when we remember the close resemblance of these drugs in alkaloidal composition. The following are the chief points of difference. (1) Hyoscyamus contains **hyoscine** in minute quantities. This is a powerful **cerebral** and **spinal sedative**, and therefore the excitation and delirium occasioned by belladonna are not so evident when hyoscyamus is given; indeed, that may, owing to the hyoscine in it, distinctly depress the higher functions of the brain. The heart is not quite so powerfully affected by hyoscyamus as by belladonna, for hyoscine has a comparatively feeble cardiac influence. Still it is, of course, affected by the hyoscyamine, which acts like atropine. (2) **Hyoscyamus increases the peristaltic contractions** of the intestines more powerfully than

belladonna, and at the same time it is more efficient in relieving the griping of other purgatives. (3) Hyoscyamus has a more markedly sedative action on the urinary unstriped muscle than belladonna. (4) Hyoscine diminishes intra-ocular tension; therefore hyoscyamus does not affect this so much as belladonna.

Pure atropine and pure hyoscyamine have precisely the same actions, but hyoscyamine is twice as powerful in its action on the nerve-endings in the salivary glands, heart, and pupil.

Therapeutics.

Hyoscyamus might be used for the same purposes as belladonna, but is chiefly employed in combination with purgatives to diminish griping. It is also given to relieve vesical spasm in calculus, cystitis, and prostatitis. The doses of hyoscyamus are larger than those of the corresponding preparations of belladonna.

Hyoscine, often called scopolamine, is employed as a cerebral depressant, and is used in acute mania, delirium tremens, febrile delirium, and insomnia, sometimes with good results. It is often given in asylum practice, but must be used carefully, as the activity of different specimens varies, and fatal results have followed its use. It should never be employed if the patient is weak. Hyoscine is usually given subcutaneously. A single dose should rarely exceed $\frac{1}{100}$ gr. (0·6 milligrm.) of the hydrobromide. Chorea, paralysis agitans, and other convulsive diseases have been treated with it, but the convulsions always recur when it is discontinued, still an occasional dose is sometimes useful in paralysis agitans. Combined with morphine it is largely given to diminish sensibility before a general anæsthetic and in labour (twilight sleep). Whether this is harmful to the new-born child from depression

of its respiratory centre from such of the drugs as have passed into its circulation is undecided.

Duboisinæ Sulphas.—(Not official.)

The sulphate of a mixture of alkaloids obtained from the leaves of *Duboisia myoporoides.* Duboisine consists chiefly of hyoscine and hyoscyamine. Its actions are like but more powerful than those of atropine, and discs containing $\frac{1}{5000}$ of a grain ($\frac{1}{80}$ milligrm.) are used to dilate the pupil.

GRINDELIA.

Grindelia.—The dried leaves and flowering tops of *Grindelia camporum.*

CHARACTERS.—Stems slender, yellow, smooth. Leaves about 4 centimetres long, oblong, sessile, pale green, rigid, brittle, glabrous. Flower-heads yellow, hard, resinous. Odour aromatic. Taste aromatic and bitter.

Preparation.

Extractum Grindeliæ Liquidum.—Grindelia, 10; sodium bicarbonate, 1; distilled water, 5; alcohol (90 per cent.) to produce 10. Percolate.

Dose, 10 to 20 m.—6 to 12 decimils.

ACTION AND THERAPEUTICS.

In small doses grindelia is a mild stomachic and cardiac sedative, but its main action depends upon the fact that in its excretion by the bronchial mucous membranes it acts as an expectorant, and also, like atropine, relaxes the muscular coat of the bronchial tubes, and this probably explains its efficacy in asthma. Two or three doses of twenty or thirty minims of the liquid extract (in milk, to prevent the resin, which is precipitated by excess of water, adhering to the vessel) given every twenty minutes will often allay the paroxysms of asthma. Between the attacks this dose should be taken thrice a day. The same quantity may with advantage be added to mixtures prescribed for chronic bronchitis, for then not only is grindelia an expectorant, but it relieves the

asthma-like paroxysms which so often accompany bronchitis. It is very bitter; its taste is best concealed by Spiritus Chloroformi.

In America cloths soaked in a lotion of 1 fl. dr. of the fluid extract to 6 fl. oz. of water are applied to the skin for the dermatitis caused by *Rhus toxicodendron*, the poison ivy. The same lotion is used for burns, and as an injection in gleet and leucorrhœa.

CANNABIS INDICA.

Cannabis Indica.—Indian Hemp. The dried flowering or fruiting tops of the pistillate plant of *Cannabis sativa*, from which the resin has not been removed. India.

CHARACTERS.—In compressed dusky green masses, consisting of the branched upper part of the stem bearing the remains of flowers, leaves, and a few ripe fruits, and compressed by adhesive resin. The upper leaves are simple, alternate, 1–3-partite; the lower opposite and digitate. The fruit is one-seeded, supported by a bract.

COMPOSITION.—(1) The active constituent is a resin to which many names have been given; that best known is cannabin, its active principle is cannabinol; (2) a volatile oil, consisting chiefly of a sesquiterpene, cannabene; (3) choline.

INCOMPATIBLE.—Water, which precipitates the resin.

Preparations.

1. Extractum Cannabis Indicæ.—Alcoholic. **Dose, ¼ to 1 gr.—16 to 60 milligrms.**

2. Tinctura Cannabis Indicæ.—Extract, 1; alcohol (90 per cent.), 20. Simple solution.

Dose, 5 to 15 m.—3 to 10 decimils—should be triturated with mucilage before water is added, as this precipitates the very bulky resin.

Tincture of Indian Hemp is contained in Tinctura Chloroformi et Morphinæ Composita.

Synonyms.—Haschisch is a confection of the drug. Gunjah, or ganga, is the dried flowering tops of the cultivated female plants which are coated with resin. Churrus or charas is the resin scraped off the leaves. Bhang is the dried leaves; in some provinces it means powdered ganga made into a drink. Ganga and charas are often smoked like tobacco.

Action.

External.—None is known.

Internal.—The effects of cannabis indica vary very much in different people. This is partly due to the uncertain strength of the preparations of the drug, and partly to individual peculiarities, but generally the symptoms are somewhat as follow. After some time, usually from half an hour to two or three hours, there is a pleasurable sensation of mild intoxication; the patient is particularly gay, joyous, and pleased with everything; he will laugh and smile on the slightest provocation, and is himself able to say sharp, witty things. Pleasant ideas flit through his mind with wonderful rapidity, so that time seems to him much extended. Generally the ideas are quickly forgotten, but sometimes the memory of them remains after recovery. The eyes are bright, the pupils may be dilated. The limbs feel heavy, and there is a marked lowering of general sensibility, so that he scarcely feels a severe pinch; this may pass on to complete anæsthesia. There may be headache. After a time sleep, which is often accompanied by delightful dreams, comes on. The drug is frequently taken in the East to produce the early pleasurable symptoms, and, in moderation, it causes no harm. Very few take it to excess, but in them it leads to loss of appetite and strength, trembling, and insanity. Cannabis indica is reputed to occasionally produce sexual excitement, but this is incorrect. The most constant effect is that time seems prolonged. Minutes appear to be days. Large doses given to a dog only made him sleepy, and uncertain on his legs, but he appeared contented and pleased. Much the same results followed when a monkey was made to inhale the smoke daily for 181 days.

THERAPEUTICS.

It has been given with success in migraine and neuralgia, but it very often fails to afford relief. Its use as an hypnotic has been discarded. The tincture is very difficult to prescribe, because of the voluminous precipitate of resin which falls on the addition of water. Mucilage must be used to suspend it, and the taste should be covered with spirit of chloroform.

CAFFEINE.

Caffeina.—Caffeine. $C_8H_{10}N_4O_2,H_2O$. *Synonyms.*—Theine, Guaranine.

SOURCE.—An alkaloid usually obtained from the dried leaves of *Camellia thea*, common tea, or from certain other plants.

CHARACTERS.—Colourless, silky, inodorous, acicular crystals. *Solubility.*—1 in 80 of cold water, 1 in 1 of boiling water, 1 in 40 of alcohol (90 per cent.), 1 in 400 of ether, 1 in 7 of chloroform. The solubility of caffeine is perfect in cold water, if for each grain of caffeine ½ a grain of sodium salicylate is added. The addition of alcohol as in tinctures or spirit of chloroform does not impair the solubility. Tea contains 3 to 5 per cent. (hence the name theine). Coffee, 1·3 per cent. (coffee leaves contain much more). Guarana (the seeds of *Paullinia cupana*), 5 per cent. (hence the name guaranine). Maté (Paraguay tea, the leaves of *Ilex paraguayensis*), 0·5 per cent. Kola nut (which is used as a beverage in Africa), 3 per cent.; this is the fruit of *Sterculia acuminata.* Youpon (Apalache tea) also contains caffeine. Most of these substances also contain theobromine. Caffeine is trimethyl-xanthine, theobromine is dimethyl-xanthine, and both can be prepared synthetically from xanthine. It is a feeble alkaloid, its salts being very liable to split up.

INCOMPATIBLES.—Potassium iodide, salts of mercury, and tannic acid.

Dose, 1 to 5 gr.—6 to 30 centigrms.

Caffeinæ Citras.—Caffeine Citrate. $C_8H_{10}N_4O_2$ $C_6H_8O_7$.

SOURCE.—Mix caffeine with citric acid, moisten with distilled water and dry.

Characters.—A white, inodorous powder. A feeble salt, easily splitting up. Taste and reaction acid. *Solubility.*—1 in 32 of water, 1 in 22 of alcohol (90 per cent.), 1 in 10 of a mixture of 2 of chloroform and 1 of alcohol (90 per cent.). With 1 in 10 of water, it forms a clear, syrupy, supersaturated solution, but directly the mixture is stirred the caffeine citrate is precipitated; then, if more water is added, this precipitate re-dissolves. This peculiarity in the solubility of caffeine citrate often leads to mixtures being prescribed in which the caffeine citrate is precipitated, but then it can be suspended in mucilage. If caffeine citrate is prescribed with sodium salicylate, a very bulky precipitate forms.

Incompatibles.—The same as of caffeine.

Dose, 2 to 10 gr.—12 to 60 centigrms.

Caffeinæ Citras Effervescens.—Effervescing Caffeine Citrate.

Source.—Mix citric acid, tartaric acid, caffeine citrate. Also mix sodium bicarbonate, refined sugar. Incorporate the two mixtures, heat to 100°C. When the mixture is granular pass through a sieve, and dry at a temperature not exceeding 55°C.

Dose, 60 to 120 gr.—4 to 8 grms.

Action.

External.—None.

Internal.—*Alimentary canal.*—Excessive tea-drinking may cause indigestion, but this is probably induced by the tannin in the tea, and not by the caffeine. The teeth of tea-tasters are liable to decay. Coffee is, with some persons, slightly laxative; it is not known to what ingredient this is due.

Heart.—Caffeine is freely absorbed. It produces no change in the blood. Moderate doses have the reputation of increasing the rate of the heart, but this is probably incorrect, as is the statement that it is a cardiac stimulant. Large doses cause the heart to become irregular. In man the heart is

occasionally at first slowed from stimulation of the inhibitory apparatus, and this may be the cause of the palpitation experienced by some who take too much tea.

Vessels.—Caffeine has very little or no effect on these or on the blood pressure.

Respiration.—In animals the rate and extent of breathing are increased by caffeine from stimulation of the respiratory centre.

Nervous system.—It is well known that tea and coffee stimulate the cerebrum. This is due to the caffeine in them. The patient becomes wakeful, the mental activity and capability for work are increased, the reasoning powers being quite as much affected as the imagination. In this respect the cerebral stimulation of caffeine differs from that of opium, and also in that the excitation is not incoordinate, nor is it soon replaced by sleep. The special senses are rendered more alert. Very excessive tea-drinking causes trembling of all the muscles of the body, and makes the patient extremely "nervous."

In man the spinal cord and muscles are very little affected by caffeine, but in some frogs the spinal cord is decidedly stimulated, and convulsions occur; in other species the muscles are thrown into a state of rigidity, which is clearly due to an action on the muscles themselves, for it follows the local application of caffeine to an isolated muscle, the fibres of which become white and opaque, the transverse striation disappears, and rigor supervenes. Sometimes the muscle curve is altered in character. In man the power to do muscular work is increased by caffeine. Motor and sensory nerves are uninfluenced in all animals.

Kidneys.—Caffeine by an ill-understood direct action on the renal cells causes a great increase in the amount of urine—chiefly its fluids, but to a less extent its solids. Thus caffeine is a good local

diuretic, but theobromine is better, because it is more powerful and does not cause sleeplessness.

Metabolism.—Many elaborate experiments have been made upon the action of caffeine on tissue waste; the outcome of them appears to be that it increases metabolism, for it leads to an increased excretion of urea and carbonic acid. It increases the excretion of xanthin in the urine because it loses its methyl groups in its passage through the body; the increased urea excreted is derived partly from the xanthin. Toxic doses may cause a rise of temperature.

Therapeutics.

Heart.—Caffeine has been used in heart disease, when, as in aortic or mitral obstruction, a purely stimulant effect is desired; large doses, 3 or 8 grains (2 to 5 decigrms.) a day of caffeine, are often easily borne, and may be combined with strychnine, but its efficacy is very doubtful. It will not replace digitalis. It is, on account of its diuretic action, especially valuable in cardiac cases in which there is dropsy. Tea and coffee are, in some persons, liable to produce irregularity of the heart.

Kidney.—Small doses of caffeine are powerfully diuretic, and are therefore used in heart disease, ascites, and pleuritic effusion. Their action is often much aided by giving digitalis at the same time. As the drug acts directly on the kidney, it should be given cautiously in renal disease. Many patients so soon become used to it, that at the end of a week it has lost its power of producing diuresis.

Nervous system.—Occasionally it cures migraine and certain headaches, but it is not so useful as phenazone or phenacetin. A dose of the effervescing citrate in half a tumbler of water is a pleasant form in which to give caffeine for this purpose.

It may be rendered sufficiently soluble for subcutaneous administration by mixing it with a solution of salicylate of sodium.

THEOBROMINE AND SODIUM SALICYLATE.

Theobrominæ et Sodii Salicylas.—$Na_2C_{14}H_{12}N_4O_5$. *Synonym.*—Diuretin.

SOURCE.—Obtained by combining sodium hydroxide, theobromine, and sodium salicylate. Should be preserved in stoppered amber-coloured bottles.

CHARACTERS.—A white amorphous powder. No odour. Taste sweetish. Soluble in 1 part of water.

Dose, 10 to 20 gr.—6 to 12 decigrms.

ACTION AND THERAPEUTICS.

Theobromine (the chief principle in cocoa), often prescribed as diuretin, is an excellent diuretic; it acts on the renal epithelium, and is most efficacious in relieving œdema in diseases of the kidneys and heart, especially if digitalis is given at the same time. It is said not to produce much depression, but it may occasionally cause serious symptoms. Theobromine itself may be given in cachets in doses of 1 to 5 gr. (6 to 30 centigrms.). There are many salts of it in the market, but the above official compound with sodium salicylate is the best.

Guarana.—(Not official.)

Synonym.—Brazilian cocoa. The seeds of *Paullinia cupana*. Brazil. They are roasted, powdered, and made into a stiff paste with water and then dried.

CHARACTERS.—Cylindrical hard rolls of dried paste.

COMPOSITION.—The chief constituent is 2·5 to 5 per cent. of caffeine (*see* p. 403).

Dose, 15 to 60 gr.—1 to 4 grms.—in powder or infused in a cup of boiling water.

Preparation (B. P. C.).

Tinctura Guaranæ.—Guarana in powder, 25; alcohol (60 per cent.), 100. Macerate.

Dose, 1 to 2 fl. dr.—4 to 8 mils.

Action and Therapeutics.

Although there is no reason to believe that guaranine does not produce the same actions on the nervous system, heart, and kidneys as caffeine, yet it is rarely used except for sick headaches, but in these cases it is sometimes of great service.

Class II.—**Vegetable Drugs acting chiefly on the Spinal Cord.**

NUX VOMICA.

Nux Vomica.—*Synonyms.*—Poison nut. The dried, ripe seeds of *Strychnos nux-vomica.* East Indies. The St. Ignatius bean is *Strychnos ignatia*, it is different in shape, and contains more strychnine.

Characters.—Disc-shaped, 2 to 2½ centimetres in diameter, 6 millimetres thick. Flat or concavo-convex. Margin rounded. On one surface a central scar, from which a ridge passes to the margin, and ends in a slight prominence. Externally ashen grey, glistening with short satiny hairs. Internally horny and slightly translucent. No odour. Taste extremely bitter.

Composition.—The chief constituents are—(1) *Strychnine* (see p. 409), 0·9 to 1·9 per cent. (2) *Brucine*, which is dimethoxylstrychnine, $C_{23}H_{26}N_2O_4$, 0·9 to 1·5 per cent. Colourless prismatic crystals or pearly flakes. Very bitter, but less so than strychnine. *Solubility.*—1 in 3200 of cold water, freely in alcohol. It has the same action as strychnine, but is considerably less powerful and slower in its effects. Strong sulphuric or nitric acid gives a blood-red colour. (3) *Igasuric acid*, with which the strychnine and brucine are united. (4) *Loganin*, an inert glucoside.

Powdered Nux Vomica, when used for official purposes other than the production of standardized preparations, must be adjusted, if necessary, by the addition of powdered Milk Sugar to contain 1·25 per cent. of Strychnine.

Dose, 1 to 4 gr.—6 to 25 centigrms.

Preparations.

1. Extractum Nucis Vomicæ Liquidum.—Alcoholic (70 per cent.). *Standardized to contain* 1·5 *per cent. of strychnine*, that is, $1\frac{1}{2}$ gr. in 110 m.

Dose, 1 to 3 m.—6 to 18 centimils.

2. Extractum Nucis Vomicæ Siccum.—The liquid extract is evaporated and diluted with calcium phosphate. *Standardized to contain 5 per cent. of strychnine.*

This is Extractum Nucis Vomicæ, B. P. 1898.

Dose, $\frac{1}{4}$ to 1 gr.—10 to 16 milligrms.

3. Tinctura Nucis Vomicæ.—Liquid extract of nux vomica, 5; water, 15; alcohol (90 per cent.), to produce 60. Mix. *Standardized to contain* 0·125 *per cent. of strychnine*, that is, 1·25 milligrms. in each millilitre, or $\frac{1}{13}$ gr. in 1 fl. dr.

This contains one half as much strychnine as in B. P. 1898.

Dose, 5 to 15 m.—3 to 10 decimils.

Strychnina.—Strychnine. $C_{21}H_{22}N_2O_2$.

Source.—This alkaloid is prepared from the seeds of nux vomica and other species of *Strychnos.*

Characters.—Minute, colourless, odourless, trimetric prisms. Intensely bitter; can be tasted in a solution of 1 in 30,000 (but only to be tasted in weak solutions, as it is so poisonous). *Solubility.*—1 in 5760 of cold, 1 in 2500 of hot, water, 1 in 6 of chloroform, 1 in 150 of alcohol (90 per cent.). Gives no colour with nitric or sulphuric acids. Add to a crystal strong sulphuric acid, and then add a particle of potassium bichromate; a beautiful violet colour, passing to brown and green, is formed. *Resembling strychnine.*—Salicylic acid.

Incompatibles.—Alkalies, iodides, bromides; the last are especially dangerous, for the precipitated bromide of strychnine falls slowly.

Impurity.—Brucine, distinguished by tests.

Dose, $\frac{1}{64}$ to $\frac{1}{16}$ gr.—1 to 4 milligrms.—in solution, or made in a pill with sugar of milk (to thoroughly divide it) and glycerin of tragacanth.

Preparation.

Syrupus Ferri Phosphatis cum Quinina et Strychnina.—Each fl. dr. represents $\frac{1}{32}$ gr. strychnine (*see* p. 193).

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

Strychninæ Hydrochloridum. — Strychnine hydrochloride. $C_{21}H_{22}N_2O_2HCl,2H_2O$.

CHARACTERS.—Small, colourless, trimetric prisms, which readily effloresce in air; very bitter. *Solubility.*—1 in 60 water, 1 in 60 alcohol (90 per cent.).

Dose, $\frac{1}{64}$ to $\frac{1}{16}$ gr.—1 to 4 milligrms.

Preparations.

1. Injectio Strychninæ Hypodermica. — Strychnine hydrochloride, 0·75; distilled water, 100. *Strength.*—0·75 per cent.; $\frac{3}{4}$ gr. in 110 ♏.

Dose, 5 to 10 m.—3 to 6 decimils.

2. Liquor Strychninæ Hydrochloridi.—*Synonym.*—Liquor Strychninæ. Strychnine hydrochloride, 1; alcohol (90 per cent.), 25; distilled water to make 100. *Strength.*—1 per cent.: that is, 1 gr. in 110 ♏—1 grm. in 100 millilitres.

Dose, 2 to 8 m.—12 to 50 centimils.

ACTION.

External.—Strychnine is a very powerful **antiseptic.** Brucine is a local anæsthetic.

Internal.—*Gastro-intestinal tract.*—Being intensely bitter, nux vomica is a good **stomachic,** increasing the vascularity of the gastric mucous membrane, the secretion of gastric juice, and the movements of the stomach by its action on the mouth, just like calumba (*q.v.*), or any other bitter; consequently it aids digestion and sharpens the appetite. It is a stimulant to the intestinal muscular coat, and by this means it **increases peristalsis,** and is therefore **purgative.**

Blood.—Strychnine is absorbed into the blood, and circulates as such. If blood is mixed with

strychnine and shaken with air it contains more oxygen and less carbonic acid than it would have done had the strychnine been absent; but there is no evidence that strychnine in small doses alters the oxidizing power of living blood.

Spinal cord.—Strychnine causes convulsions. They are not cerebral, for they occur if the spinal cord is separated from the brain. They do not depend upon excitation of the motor nerves or muscles, for they are absent in a limb the spinal anterior nerve-roots of which are cut. They occur if the posterior nerve-roots are cut, provided the proximal end is stimulated. Therefore they must be spinal; and this is proved by the fact that if all the vessels of the lower part of the spinal cord are ligatured just at their entry into the cord, so that this is the only part of the body deprived of its blood supply, and strychnine is injected into the blood, convulsions occur in all the muscles except those the nerves of which spring from the part of the cord which the strychnine cannot reach. Again, if an animal be convulsed by strychnine, and a probe be slowly passed down the spinal canal, the convulsions will gradually cease from above downwards. But a peripheral stimulus, particularly if sharp and sudden, so easily excites convulsions when strychnine has been given that we are justified in assuming that every convulsion is excited by a peripheral stimulus, and often so slight as not to be evident. Further, strychnine enormously exaggerates the conduction power of the cord in such a way that general convulsions reflexly follow a very slight local stimulus. It is believed that the precise part of the spinal cord stimulated to increased excitability by strychnine is that immediately on the afferent side of the anterior cornual cells.

When a muscle contracts, centripetal impulses go from it up afferent nerves, and these reinforce the inhibitory impulses going to the opposing muscles. Recent

research (Sherrington) shows that strychnine reverses in the cord these inhibitory impulses, making them excitory. Usually we are unaware of these inhibitory impulses, but when they become excitory they are manifest, and especially so if strychnine has been given, for then, as just mentioned, the excitability of the cord is heightened. The patient makes some slight movement, which would normally be associated with unappreciated inhibition of the extensors of the spine, but strychnine converts these inhibitory into powerful exciting impulses, with the result that powerful contraction of the extensors takes place (opisthotonos). In the same way, an attempt to open the jaw becomes a powerful contraction (lockjaw).

Muscles and Nerves.—Even with enormous doses the muscles and afferent nerves are unaffected. Towards the end of a case of poisoning the functional activity of the motor end-organs is depressed. This is due to direct action on them, and occurs readily in some species of frogs.

Brain.—The convolutions are quite unaffected by ordinary doses, but large doses slightly stimulate the cells of the motor area; but as in the cord, so here, normal unappreciated inhibitory impulses become powerfully excitory. Thus stimulation of the very part of the motor area that would normally produce, say, flexion of one hind limb now produces strong extension of that limb. The centres in the medulla, which are really the continuation upwards of the anterior cornua of the cord, are powerfully stimulated by the same mechanism, especially the respiratory centre. The vaso-motor centre is also considerably excited, and chiefly for this reason the blood-pressure rises from the very first. The cardiac centre is but slightly affected.

Circulation.—Strychnine does not directly affect the heart but its action may be increased by the great rise of blood-pressure. This is caused by the

contraction of the vessels all over the body, which is brought about first by the direct excitation by the strychnine of the medullary vaso-motor centre, and subsequently by its asphyxial stimulation, and also by the increased peripheral resistance which must occur from the frequent contraction of all the muscles. Strychnine perhaps also to some extent causes vascular constriction by direct stimulation of the muscle of the arterioles.

Respiration.—Respiration is rendered quicker and deeper because strychnine excites the spinal and medullary respiratory centres. The respiratory muscles are implicated in the general convulsions, and the patient becomes livid and ultimately asphyxiated owing to exhaustion of them, and to their prolonged contraction during the convulsive spasms. The heart continues to beat after death, which is entirely due to failure of respiration. The excessive muscular contractions occasionally cause a rise of temperature, but so rarely that often the loss of heat must be greatly increased.

Special senses.—Smell, hearing, touch, and sight are sharpened by strychnine. The field of vision, especially for blue, is said to be enlarged. Some of these effects are probably central and others due to local action on the peripheral sense organs.

Elimination. — Strychnine is eliminated unchanged in the urine. It is excreted rather slowly, and therefore tends to accumulate in the system. Tolerance is never established. For a clinical account of strychnine poisoning *see* Toxicology.

Brucine and thebaine act like strychnine, but methylbrucine, methylthebaine, and methylstrychnine do not influence the cord, but paralyse the ends of the motor nerves like curare.

Strychnine acts on all animals in the main as on man, but some birds and guinea-pigs are less susceptible to it, for they absorb it slowly.

Therapeutics.

External.—Strychnine is so poisonous that its use as an antiseptic would not be safe.

Internal.—*Gastro-intestinal tract.*—Tincture of nux vomica is very largely given with excellent results as a bitter stomachic and carminative, especially in cases in which the feebleness of digestion is merely part of generally feeble health. A mixture of dilute hydrochloric acid, gentian, and nux vomica is of great service in these cases. As the digestion improves the general health improves. Because of its power to stimulate peristalsis, nux vomica is a valuable drug for cases of constipation in which the contractile strength of the muscular coat of the intestine is weak; usually this is part of a general weakness of the whole body. The constipation of anæmia, which can be very successfully treated by a pill of extract of nux vomica and iron sulphate, is a good instance of this variety of constipation.

Circulation.—In cases of heart disease in which digitalis is inadmissible, nux vomica and strychnine are used as cardiac stimulants, and for this purpose they are often combined with caffeine. Patients almost dead from failure of the heart in the course of chronic cardiac disease may apparently be brought round by the subcutaneous injection of strychnine; but some doubt its efficacy.

Respiration.—Strychnine may be combined with expectorants as it stimulates the respiratory centre; and it is extremely serviceable when from any cause, such as severe bronchitis or pneumonia, the respirations are feeble and shallow; it is then best given subcutaneously in frequently repeated doses.

Nervous system.—It has been given for a number of nervous diseases, but with no certain good results, for when the disease is not in the anterior cornua strychnine is hardly indicated; and if it is in this

part of the cord, it is doubtful whether it is advisable to stimulate the part of the body which is diseased.

Toxicology.

In about an hour after a poisonous dose the patient begins to feel uneasy from a sensation of impending suffocation. The tetanic convulsions then commence with great violence, nearly all the muscles of the body being affected at once. The limbs are thrown out, the hands are clenched, the head is jerked forwards and then bent backwards, and the whole body is perfectly stiff from the violence of the contractions. The pulse is very rapid; the temperature may rise. Hearing and sight are acute. The convulsion lasts a minute or two, then the muscles relax, and the patient feels exhausted and sweats all over. The intermission is short, convulsions soon come on again, and again there is a relapse to the state of muscular relaxation. The convulsions now rapidly increase in severity, and owing to the violent contractions of the muscles of the back, the patient is in the position of opisthotonos, resting on his head and his heels. The abdominal muscles are as hard as a board, the chest is fixed, the face becomes livid, the eyeballs are staring. The contraction of the muscles of the face causes a risus sardonicus; but those of the jaw are not affected till quite the end. Consciousness is retained to the last. The slightest noise or even a bright light will reflexly bring on the convulsions, which may jerk the patient out of bed. Ultimately he dies from exhaustion and asphyxia. The smallest dose of strychnine known to have killed is half a grain. *Post mortem.*—The usual appearances of death by asphyxia are seen.

Strychnine poisoning is liable to be confounded with *tetanus*, but in this disease symptoms come on more slowly, the muscles of the jaw are implicated very early, and there is continuous muscular rigidity with paroxysmal exacerbations, but never complete muscular relaxation.

Treatment.—Put the patient at once under chloroform or ether. Wash out the stomach with potassium permanganate as for opium (*see* p. 376). Apomorphine should be given hypodermically if the jaw is locked. Inject large doses of potassium bromide and chloral hydrate *per rectum*. Use amyl nitrite inhalations, and if possible artificial respiration.

Antagonism.

In a sense strychniné is antidotal to chloral and morphine, but it is not a strict antidote, for they act chiefly on the cerebrum. Still, chloral is valuable in strychnine poisoning, and

although the antagonism with Calabar bean and gelsemium is more accurate, as both depress the anterior cornua, yet they are of very little use in strychnine poisoning.

PHYSOSTIGMINE SULPHATE.

Physostigminæ Sulphas.—$(C_{15}H_{21}N_3O_2)_2,H_2SO_4$.
Synonym.—Eserine sulphate.

Source.—The sulphate of an alkaloid obtained from Calabar bean, the seeds of *Physostigma venenosum.*

Characters.—Minute white crystals, becoming yellow on exposure to light and air. Bitter taste. Very soluble in water and alcohol. The solution in salicylic acid is permanent.

Dose, $\frac{1}{64}$ to $\frac{1}{32}$ gr.—1 to 2 milligrms. Best given subcutaneously.

Preparation.

Lamella Physostigminæ.—Physostigmine sulphate, $\frac{1}{1000}$ gr. (0·065 milligrm.); gelatin and glycerin together, $\frac{1}{50}$ gr. (1·3 milligrms.) in each lamella.

Action.

External.—None.

Internal.—*Mouth.*—After physostigmine is absorbed it increases the salivary secretion; and this has been shown to be due to stimulation of the terminations of the secretory nerves in the glands. Other secretions are increased, probably in the same way. After a time the flow of saliva ceases, because the drug has so acted on the circulation as to constrict the vessels, and consequently the flow of blood through the salivary glands is diminished.

Stomach and Intestines.—The muscular coat of the stomach and intestines is greatly stimulated by the direct action of the drug circulating through it. The result is that after a large dose vomiting and purging occur. Physostigmine is quickly absorbed.

Circulation.—No influence on the blood is known. The effect on the heart is obscure, but it appears that the irritability of the peripheral terminations of the

vagus is at first increased, and that consequently the heart is slowed. Very large doses are said to decrease the irritability of the vagus. In addition to its effects on the vagus, physostigmine, in frogs at least, powerfully stimulates the contractile force of the heart. The beat is therefore both more forcible and slower. Ultimately the organ is paralysed and stops in diastole.

The blood-pressure rises very much; this is largely due to the increased force of the cardiac beat, partly to stimulation of the vaso-motor centre, partly to contraction of all the unstriped muscle of the abdominal viscera, driving much blood out of the abdomen. It is not known for certain if the unstriped muscle of the arteries is stimulated. Analogy would lead us to suppose that it is.

Respiration is first quickened but soon retarded, and death takes place from asphyxia. Three factors at least are probably concerned in bringing about these results. The ends of the vagi in the lungs are stimulated, for if these nerves are cut and physostigmine is administered there is no primary quickening of respiration. Physostigmine, from its action on involuntary muscular fibre, causes contraction of that in the bronchial tubes, with consequent constriction of them. Lastly and most important, the activity of the respiratory centres in the medulla and cord is depressed.

Nervous system.—Brain.—Even in fatal doses consciousness is unimpaired. The only part of the brain certainly known to be affected is the respiratory centre, but it has been said that the motor cortex is temporarily excited.

Spinal cord.—It is here that physostigmine produces its most characteristic effects. Reflex activity is inhibited; by exclusion it can be shown that this is not owing to any influence on the nerves or voluntary muscles, therefore it is due to depression of the

spinal cord. The most conclusive proof of this is the direct application of the drug to the cord. There is, then, at first, from the irritation, which is caused by almost any substance, a slight increase of reflex excitability, but this soon gives way to complete abolition of it. Later on, the posterior part of the cord is also paralysed, so that there is a diminution of cutaneous sensibility.

Voluntary muscles and their nerves.—Muscular twitchings follow large doses in many animals. These appear to be due to action on the motor nerve terminations; sensory nerves are unaffected.

Involuntary muscles.—We have already seen that the involuntary muscles of the intestines, stomach, and bronchial tubes are made to contract by physostigmine; so also are those of the spleen, uterus, bladder, and iris. Probably in all these instances it is the junctions between the motor nerves and the muscle fibres that are affected, for in this action physostigmine is the antagonist to atropine.

Eye.—Physostigmine applied locally to the conjunctiva or introduced into the circulation causes contraction of the pupil, spasm of accommodation from direct stimulation of the ends of the motor nerves of the iris and the ciliary muscle. There is a diminution of intra-ocular tension. Thus, also as regards both secretions and the eye, physostigmine is antagonistic to atropine.

The action of physostigmine is much more constant than that of Calabar bean, perhaps because the other active principles in the bean interfere with the action of physostigmine.

Therapeutics.

Involuntary muscles.—Because it stimulates nerve terminals in unstriped muscle physostigmine has been recommended for chronic constipation,

atony of the bladder, and chronic bronchitis with deficient power of expectoration, and although rarely given for these purposes. subcutaneously, it is useful to unlock the bowels after abdominal operations.

Spinal cord.—Physostigmine has been used for tetanus, and some cases of recovery have been reported. It must be administered boldly. The extract has often been given, but it is better to inject physostigmine sulphate under the skin. Doses of $\frac{1}{32}$ gr. (2 milligrms.) frequently repeated may be employed, but the patient must be carefully watched. Physostigmine has been given as an antidote for strychnine poisoning.

Eye.—The lamellæ are placed in the eye to break up adhesions of the iris, to diminish intra-ocular tension, and to prevent prolapse of the iris after wounds or ulcers of the cornea. It is also employed in glaucoma, in paralysis of the iris and ciliary muscles, and to prevent the entrance of light into the eye in photophobia. If used in solution, $\frac{1}{2}$ to 2 gr. (3 to 12 centigrms.) of physostigmine sulphate to 1 fl. oz. (30 mils) of water is the usual strength.

Antagonisms.

It will be observed that in its actions on the pupil, on secretion, on the heart, and on respiration, physostigmine is antagonistic to atropine. In its action on the spinal cord and respiratory centre it is antagonistic to strychnine.

GELSEMIUM.

Gelsemii Radix.—Yellow Jasmine. The dried rhizome and root of *Gelsemium nitidum.* From the south-eastern United States.

Characters.—Nearly cylindrical, about 15 centimetres long and 6 to 18 millimetres thick, occasionally small rootlets mixed with or attached to the larger pieces. Thin cortex, porous yellowish radiate wood, conspicuous straight medullary rays. Rhizome brown; dark violet cork. Root yellowish brown. Odour aromatic. Taste bitter.

Composition.—The chief constituents are—(1) Gelse-

mine, a very poisonous alkaloid, existing as yellowish-white minute crystals, soluble in alcohol and ether, but sparingly in water. The hydrochloride, which is freely soluble in water, is the common salt. (2) Gelseminine, a yellowish-brown, bitter substance, soluble in alcohol and ether, sparingly in water.

There is much confusion between these bodies, for gelsemine is often called gelseminine and vice versa.

Dose, of gelsemine hydrochloride, $\frac{1}{60}$ to $\frac{1}{20}$ **gr.—1 to 3 milligrms.**

Preparation.

Tinctura Gelsemii.—Gelsemium, 1; alcohol (60 per cent.), 10. Percolate.

Dose, 5 to 15 m.—3 to 10 decimils.

ACTION.

External.—None.

Internal.—Gelsemium produces no effect on the stomach or intestines. Its powerful general physiological effects are due to the gelsemine in it.

Brain.—In poisoning by gelsemium consciousness is maintained till the end; the drug, therefore, has no power on the higher cerebral centres.

Spinal cord.—The most marked symptom produced by gelsemium is paralysis of all the muscles of the body; and by a series of experiments, like those used for strychnine, this can be shown to be due to depression of the activity of the cells of the anterior cornua of the spinal cord. If a larger dose is given the whole of the lower neurons is depressed, and hence the peripheral motor nerves and their endings are paralysed. The result of the action of the drug is that the patient may be unable to walk, or if he can the gait is staggering; his general sensibility is somewhat impaired. Convulsions may be produced. The cause of these cannot be made out, for they appear to be neither cerebral, spinal, nor peripheral.

Eye.—Gelsemium soon causes disturbance of vision, then follows diplopia, due to paralysis of the ocular muscles, and from the same cause the upper lid drops. The pupil is dilated. All these symptoms are

probably owing to the paralysis of the neurons of the motor centres in the floor of the fourth ventricle and the aqueduct of Sylvius, for these are the continuation upwards of the anterior cornua.

Circulation.—The action of moderate doses is not marked. Toxic doses are powerfully depressant; the force and rate of the pulse and the blood-pressure fall. This is owing to a direct action on the cells of the vagal ganglia, the drug acting like nicotine.

Respiration.—Soon after the administration of gelsemium the respiration becomes slower and more feeble; ultimately it stops, death taking place by asphyxia owing to paralysis of the respiratory centres in the cord and medulla. Before death the temperature falls, and the skin is bathed in a cold sweat. This view that the action of gelsemium is central is that of most observers, but many consider that it acts chiefly peripherally like coniine.

Therapeutics.

Gelsemium being an uncertain, very powerful poison, is not often prescribed, but sometimes it is used successfully for neuralgia and migraine. A good combination for these diseases is gelsemine hydrochloride $\frac{1}{200}$ gr. (0·3 milligrm.), with butyl chloral hydrate 3 gr. (2 decigrms.), made into a pill with mucilage, and given every two hours till the pain is relieved. It has been employed to dilate the pupil and paralyse accommodation. Discs, each containing $\frac{1}{600}$ gr. (0·1 milligrm.) gelsemine, are made for application to the eye from which it is absorbed.

Class III.—**Vegetable Drugs acting chiefly on Nerves.**

Conii Folia.—(Not official.)

Hemlock Leaves. *Synonym.* — Conium. The fresh leaves and young branches of *Conium maculatum*, the spotted hemlock, collected when the fruit begins to form (in June).

COMPOSITION.—The chief constituents are—(1) *Coniine*, $C_8H_{16}HN$, propyl piperidine, the active principle. A yellowish, oily, strongly alkaline liquid alkaloid, with a mouse-like odour and a tobacco-like taste. *Solubility.*—1 in 100 of water. It is easily obtained from the plant by distillation with alkalies. It is most abundant in the fruit. It is readily decomposed by light and heat, and the preparations of conium are therefore of very varying strengths. Its salts are much more stable. (2) Methyl-coniine, $C_8H_{16}CH_3N$. A colourless fluid alkaloid. (3) Conhydrine, a nearly inert crystallizable alkaloid.

ACTION.

External.—Coniine probably has no influence on the unbroken skin, but it has been thought to be anæsthetic when applied to painful broken surfaces. This is doubtful, for in the first place we have no proof that it can be absorbed from sores; and, secondly, experiments show that large doses have to be given to depress the activity of sensory nerves.

Internal.—*Gastro-intestinal tract.*—It may occasionally give rise to vomiting and diarrhœa, for it acts on all sympathetic ganglia like nicotine.

Circulation.—Coniine is absorbed into the blood, and circulates unchanged. It causes vacuoles to appear in the red cells. It depresses the cardiac vagal ganglia, and hence the pulse quickens; speaking generally coniine, like nicotine, paralyses peripheral ganglia; this is one cause of the fall of blood pressure. The heart beats long after breathing has ceased.

Respiration.—Owing to the profound paralysis of the respiratory motor nerve endings, and the later depression of the respiratory centre and motor part of the cord, death takes place from enfeeblement of respiration and consequent asphyxia.

Nervous system.—Nerves. — Coniine powerfully depresses the periphery of all the motor nerves. This leads to paralysis of all the muscles of the body as far as voluntary and reflex motion are concerned, but thev themselves are unaffected, retaining their

irritability to local stimuli. The motor nerve trunks and the sensory nerves are not implicated unless the dose is very large; then their conducting power is impaired. The effects on nerves are well illustrated in the death of Socrates, for he was directed to walk about till his legs felt heavy (motor paralysis), and later, when his foot was pressed he could not feel.

Spinal cord.—This remains uninfluenced till quite late; then, if poisonous doses of conium have been given, the motor cornua are feebly depressed, as is also the respiratory centre in the medulla. These actions are probably due to the methylconiine. As the amount of this is variable in different specimens, the exact period at which these effects come on varies with different preparations. In some animals asphyxial convulsions are very marked.

Brain.—Except for the respiratory centre, the whole of the brain is unaffected by coniine. Consciousness is preserved until the stage of asphyxia.

Eye.—Coniine, dropped into the eye, causes contraction of the pupil reflexly from the conjunctival irritation. But soon the pupil dilates, and accommodation is paralysed; the same usually happens when the drug is given internally. Probably these results are owing to paralysis of the terminal portions of the third nerve, for well-marked ptosis, which is due to this cause, is present, but the pupillary effects are partly due to depression of the ciliary ganglion, as coniine paralyses all peripheral ganglia.

Coniine is excreted unchanged, chiefly in the urine.

THERAPEUTICS

External.—Conium has been applied to painful ulcers and sores, but it is, for the reasons already given, doubtful whether it produces any good effect.

It has also been employed for myalgia and rheumatism, but it is quite useless.

Internal.—Conium is rarely given as a medicine, for (*a*) the amount of coniine extracted by any preparation is very variable; (*b*) the amount in the same part of different plants is inconstant; (*c*) the amount of methylconiine present is also very uncertain; (*d*) coniine is very volatile; (*e*) it is unstable, light and air making it inert. For these reasons it is probable that often the old pharmacopœial preparations contained no coniine at all. Ounces of the succus (B. P. 1898), which was believed to be the most reliable preparation, have frequently been swallowed without producing any effects. Conium has been given in spasmodic diseases, as whooping-cough, in chorea, tetanus, asthma, and epilepsy, but in all it does little or no good.

Toxicology.

The symptoms produced by a poisonous dose are in strict accordance with the physiological action. The sufferer feels his legs to be heavy; on attempting to walk he staggers, and finds he can hardly move them, and finally he has to lie down because he has no power over them. The arms become powerless, and lie motionless at his side. There is ptosis, and dimness of vision from paralysis of accommodation; the eyes are fixed, the pupil is dilated. Swallowing becomes difficult. Respiration is laboured, the voice is lost, and death takes place from asphyxia. *Post mortem.*—The organs are found congested with venous blood.

Treatment.—Emetics (p. 145), and wash out the stomach. Give tannic acid and again wash it out. Stimulants subcutaneously. Warmth to the feet. Artificial respiration.

Tabaci Folia.—(Not official.)
Tobacco Leaves. The dried leaves of *Nicotiana tabacum.*

Composition.—The chief constituents are—(1) *Nicotine*, $C_{10}H_{14}N_2$ (2–8 per cent.). A colourless, volatile, oily alkaloid, smelling and tasting like tobacco leaves, darkening with age.

Soluble in water, more so in alcohol and ether. Turkish tobacco contains hardly any. (2) Nicotianin. (3) Salts and flavouring agents.

Nicotine is the main and most active constituent of tobacco smoke. Pyridine bases are present, but not in sufficient quantity to produce any effect.

ACTION.

Tobacco leaves act in virtue of their nicotine, one of the most powerful and rapid poisons known.

External.—Nicotine is an antiseptic.

Internal.—*Gastro-intestinal tract.*—Nicotine in even minute doses ($\frac{1}{7}$ gr., 10 milligrms.) promptly produces greatly increased salivary flow, due to action on the salivary ganglionic apparatus, burning pain in the mouth, œsophagus, and stomach, horrible nausea, quickly succeeded—owing to its action on the ganglia of the gastro-intestinal muscle — by vomiting and free purging accompanied by extreme collapse. Thus there are present a rapid, very feeble pulse, intense muscular weakness, laborious respiration, partial loss of consciousness, occasional convulsions, icy extremities, and profound general collapse. A dose of nicotine may kill in three minutes, but in both man and animals a certain tolerance may be acquired.

Circulation.—Nicotine disintegrates the red cells of freshly drawn blood, but has not this effect on living blood, although the spectrum of hæmoglobin is altered, so that the corpuscles must be in some way affected. Owing to slight stimulation with subsequent depression of the vagal ganglia and a similar effect on vaso-motor ganglia the pulse is at first slowed and the blood pressure raised, but soon the beat is powerfully depressed, the pulse becomes rapid, irregular, and feeble, and the blood-pressure rises and falls irregularly and rapidly; finally it falls profoundly.

Respiration.—This is at first accelerated and deepened; ultimately it is paralysed from depression of the centre. Death is partly due to asphyxia.

Nervous system.—The higher faculties are depressed by large doses, for those poisoned become comatose within even a minute or two of taking a large dose. The convulsions occasionally observed in man, and always in the frog, are probably due to spinal stimulation. Ultimately the function of the myoneural junction of motor nerves is entirely abolished, hence intense muscular weakness. Probably the sensory nerves, and certainly the muscles, escape.

Whether injected into the circulation or applied locally to nerve ganglia, nicotine paralyses them after a brief period of stimulation, and to this many of its actions, *e.g.* gastro-intestinal, are due. After internal administration or local application of nicotine the superior cervical ganglion, for example, is paralysed, so that while post-ganglionic stimulation causes blanching of ear, dilatation of pupil and secretion of saliva, pre-ganglionic has no effect.

Eye.—A toxic dose taken internally, or the local application of nicotine to the eye, contracts the pupil of man and most animals. This will occur in excised eyes, and is therefore a local effect. With some animals nicotine is a mydriatic.

Secretion.—Nicotine first stimulates but ultimately paralyses the secretory structures of the salivary, sweat, lachrymal, and probably all other glands. It acts on the ganglionic apparatus.

Elimination.—Nicotine is eliminated partly by the lungs, but chiefly in the urine, the secretion of which it increases.

Therapeutics.

Tobacco is never used therapeutically. Formerly it was employed in the form of an enema of the leaves

to relax muscular spasm, so as to facilitate the reduction of dislocations.

Tobacco-smoking, in those who are unaccustomed to it, produces, to a greater or less degree, the symptoms of gastro-intestinal irritation and collapse just mentioned. Even in those who are used to it the smoke may produce catarrh of the pharynx. Moderate smoking raises the blood-pressure by vaso-motor constriction and quickens the pulse and respiration, and after breakfast assists the daily action of the bowels. After excessive smoking the vaso-motor centre is depressed, the blood-pressure falls, and there is general collapse. With many people smoking has an obscure effect, especially among those who lead sedentary lives, in stimulating the brain and producing a peaceable, calm state of mind. Over-indulgence in it may lead to loss of appetite, irregularity of the heart, chronic laryngeal and pharyngeal catarrh, and retrobulbar neuritis of the optic nerve. The effect of this is that the sufferer complains that objects look misty, he has a central scotoma, sometimes complete, often only for red and green, and finally atrophy of his optic nerve. Prolonged high blood pressure leads to degeneration of the arteries, and therefore prolonged excessive tobacco-smoking leads, as has been shown by Lee, experimenting with rabbits, to fibrosis of the inner and to a less extent of the middle coat, destruction of elastic fibres and deposition of calcium salts.

The pituri plant contains an alkaloid, piturine, acting exactly like nicotine. The leaves of it are used in Australia instead of tobacco.

COCAINA

Cocaine.—$C_{17}H_{21}NO_4$.

Source.—An alkaloid obtained from Coca (Erythroxylum Coca) leaves and its varieties.

Characters.—Colourless monoclinic prisms with a slightly

bitter taste followed by numbness. *Solubility.*—Almost insoluble in water. 1 in 10 alcohol (90 per cent.); 1 in 4 ether; 2 in 1 chloroform; 1 in 4 oleic acid; 1 in 12 olive oil.

Preparation.

Unguentum Cocainæ.—Cocaine, 1; oleic acid, 4; prepared lard, 20. *Strength.*—Contains 4 per cent. of cocaine.

In India prepared suet instead of prepared lard should be used.

Cocainæ Hydrochloridum.—Cocaine Hydrochloride. $C_{17}H_{21}NO_4,HCl$.

The hydrochloride of the alkaloid cocaine.

CHARACTERS.—Colourless acicular crystals or a crystalline powder. *Solubility.*—2 in 1 of water, 1 in 3 of alcohol (90 per cent.), 1 in 3 of glycerin. The solution has a bitter taste, it produces in the mouth a slight tingling followed by prolonged numbness. It is said to keep better if $\frac{1}{2}$ per cent. solution of boric acid be added to it.

Dose, $\frac{1}{10}$ to $\frac{1}{4}$ gr.—6 to 16 milligrms.

For Dangerous Drugs Act Regulations for cocaine and ecgonine *see* p. 41.

Preparations.

1. Injectio Cocainæ Hypodermica.—Cocaine hydrochloride, 5; salicylic acid (to preserve the solution), 0·15; water, 100. *Strength.*—5 per cent.

NOTE.—This was 10 per cent., B. P. 1898.

Dose, 5 to 10 m.—3 to 6 decimils—subcutaneously.

2. Lamella Cocainæ.—Discs of gelatin and glycerin each weighing $\frac{1}{20}$ gr. (3·5 milligrms.), and containing cocaine hydrochloride $\frac{1}{50}$ gr. (1·3 milligrms.)

3. Trochiscus Krameriæ et Cocainæ.—Each contains extract of krameria 1 gr. (0·06 grm.), cocaine hydrochloride $\frac{1}{20}$ gr. (0·003 grm.), with a fruit basis.

ACTION.

External.—Cocaine has little action on the unbroken skin, but if injected subcutaneously or applied to mucous membranes—as, for example, those of the eye, nose, mouth, rectum, vagina—it produces com-

plete local anæsthesia to pain and touch, so that small operations can be performed without the patient feeling them. A 5 or 10 per cent. solution of the hydrochloride is strong enough to thus paralyse the sensory nerves. Stronger solutions must be applied to abolish sensations of heat and cold and to paralyse motor nerves. If a solution is injected into the subdural space of the spine, sensation—and with larger doses motion—is abolished in the parts the nerves of which arise from the cord below the point of injection; thus by injection between the 3rd and 4th lumbar vertebræ, sensation in the lower limbs and abdomen up to the umbilicus is abolished. When applied locally cocaine stimulates vaso-constrictor nerves and hence arteries contract.

Internal.—*Gastro-intestinal tract.*—Applied to the nose or tongue cocaine abolishes smell and taste (especially for bitter substances) respectively, and when it is taken internally, the gastric mucous membrane experiences its anæsthetic influence. Therefore the sensation of hunger is deadened, and persons taking cocaine can go a long while without feeling the want of food; but the drug is not a food, for the body rapidly wastes. Digestion is not impaired. Because of its local anæsthetic effect it sometimes stops vomiting. Very large doses may lead to diarrhœa. In the organism it is quickly converted into ecgonine.

Circulation.—Large doses stimulate both the accelerator centre and the cardiac muscle, and therefore the pulse quickens, and as both the vaso-motor centre and the sympathetic nerve terminations in the arterioles are stimulated the blood-pressure rises.

Respiration.—It acts upon the respiratory centre, first stimulating it, so that the rapidity and depth of respiration are increased; but soon depression of the centre follows, the respiratory movements become feeble, of the Cheyne-Stokes type, and death takes place from asphyxia.

Nervous system.—Cerebrum.—Cocaine is a *stimulant* to the central nervous system, affecting first the higher centres, later the cord. Subsequent to stimulation depression follows. Moderate doses greatly increase the bodily and mental power, and give a sense of calm and happiness with abolition of bodily and mental fatigue. This greater physical energy renders possible the performance of long, exhausting muscular feats. For these effects, coca leaves mixed with clay or ashes are chewed by thousands of the inhabitants of Peru and the neighbouring countries. A single large dose causes mental excitement, delirium, convulsions, and ataxy, with subsequent headache and depression. The ataxy is due to impairment of conduction of sensory impressions from the peripheral sensory nerves, but this is not enough to prevent increased reflex action. An excessive indulgence in the habit of coca chewing leads to indigestion, extreme emaciation, insomnia, and enfeeblement of intellect.

Eye.—When a solution of cocaine of about 4 per cent. is dropped into the eye local anæsthesia is produced first of the conjunctiva and cornea, later of the iris. It is attained in about seven minutes, and lasts about seven minutes. At first there may be a transitory contraction of the pupil. This is probably due to reflex action, and soon it gives way to wide dilatation. The maximum is attained in an hour or two. The normal state is regained in from twelve to twenty-four hours. The dilated pupil is feebly responsive to light, and the dilatation is rapidly overcome by physostigmine. The ocular tension is slightly lowered, and the palpebral aperture is widened. Accommodation is partially, but never completely, paralysed. The vessels of the eye are constricted. These effects are chiefly due to irritation of the sympathetic, and as they are quickly produced by dropping the drug in the eye they are

probably local. All these effects are slowly produced if large doses of cocaine are taken internally.

Muscles.—The amount of muscular work of which the body is capable is increased by cocaine, by its action on the central nervous system. The excretion of urea and nitrogenous metabolism are unaltered.

Temperature.—This may rise in cocaine poisoning.

Kidneys.—Cocaine is partly excreted by these organs. In dogs the drug is mainly destroyed in the tissues, only about 5 per cent. appearing in the urine. It diminishes sexual excitability.

Therapeutics.

External.—A few drops of a 5 to 10 per cent. solution of the hydrochloride may be injected subcutaneously as a local anæsthetic when a very small operation has to be performed. Employed for larger operations by infiltration (*see* Benzamine Lactate p. 432), 0·01 to 0·1 per cent. solutions may be used. Solutions painted or dropped on may be used for operations on the mouth, throat, teeth (4 per cent.), eye (1 to 4 per cent.), ear, vagina, urethra, and rectum (4 to 10 per cent.), and they may be applied to any of these parts when they are very painful. Cocaine will relieve vulval pruritus, and has been used locally to the nose in hay fever. Painful ulcers and fissures are beneficially treated with it. Ointments, bougies, and suppositories, usually containing 2 to 5 per cent. of cocaine, which is soluble in fats while the hydrochloride is not, are very useful. A 15 per cent. solution has been injected into the gums for tooth extraction, but is not strongly recommended. Cocaine lanolin (8·5 per cent.) is applied to painful dental cavities. Oculists employ cocaine very largely to produce local anæsthesia of the eye.

Internal. —*Mouth.* —A solution is useful for

painting or spraying on to the throat previous to laryngeal examinations. The lozenges of Krameria and Cocaine are valuable for painful sore throats.

Stomach.—Cocaine in some cases allays excessive vomiting, and has been said to cure sea-sickness.

It is not often used in Europe as a medicine for its restorative effects; as already mentioned, it is not a food, and the good it does is only temporary. It is a respiratory depressant; but severe poisoning symptoms are rarely noticed unless the drug is injected. Then it may quickly cause vertigo, pallor, fainting, profound cardiac and respiratory depression with tremors and other nervous symptoms which may in very rare instances persist for months, even if the other symptoms are overcome.

Chronic Cocaine Poisoning.—Synonym, Cocamania.—The sufferer takes cocaine either for its pleasant effects or because he thinks it will help him to break himself of the morphine habit, or he takes it with morphine. It is usually administered subcutaneously. The pulse is rapid, and fainting is common. There is much wasting and the patient looks pale and death-like. Usually he suffers from insomnia and he may become acutely maniacal with delusions of persecution. Visual and other hallucinations are often present, and it is very characteristic that patients complain of little animals creeping on the skin, "cocaine bugs," they say. As a result of the cerebral stimulation, they are extraordinarily prolix in both conversation and writing.

BENZAMINÆ LACTAS.

Benzamine Lactate.—$C_{15}H_{21}NO_2,C_3H_6O_3$, the lactate of benzoyl-vinyl-diaceton-alkamine.

Synonym.—Betacaine lactate. Betacaine is also known as eucaine and β eucaine.

SOURCE.—Obtained by neutralizing benzoyl-vinyl-diaceton-alkamine with lactic acid.

CHARACTERS.—A white crystalline powder. Taste slightly bitter followed by a sensation of numbness. Soluble in 5 parts of water and 8 of alcohol.

Dose. $\frac{1}{8}$ **to** $\frac{1}{2}$ **gr.—8 to 30 milligrms.**

Action and Therapeutics.

Two artificial alkaloids allied to cocaine, viz. alphacaine ($C_{19}H_{27}NO_4$) and betacaine ($C_{15}H_{21}NO_2$), are used as local anæsthetics. The beta compound is the better, being less irritating, and when eucaine is spoken of the beta compound is meant and is official under the name of benzamine lactate. The hydrochloride is often used, but the official lactate is much better as it is more soluble. The action of benzamine is slower than that of cocaine, and weight for weight two or three times less powerful; but the anæsthesia is more prolonged, the heart and blood-vessels are not affected, and the pupil is not dilated. A 2 per cent. solution is used for the eye, a 4 per cent. for dentistry, and a 5 to 10 per cent. for mucous membranes or subcutaneous injection. It is used for large operations by infiltrating it into the tissues in the following way. Powders containing benzamine lactate 3 gr. (2 decigrms.), sodium chloride 12 gr. (8 decigrms.) are prepared: each dissolved in $3\frac{1}{2}$ fl. oz. (100 mils) of water gives a solution of 2 in 1000. This solution is injected in various places into the part about to be operated upon. The injection of 3 gr. (2 decigrms.) of benzamine hydrochloride or lactate is considered safe. Adrenalin hydro-chloride 1 in 1000 is often added with benefit, for by constricting blood vessels it delays the absorption of the local anæsthetic and stops bleeding.

Ethocaine Hydrochloride.—(Not official.)

Synonym.—Novocaine.

This substance is used in the same way as benzamine, and some say it is the better drug as it is less irritating. It is often combined with adrenalin. It is soluble in water: the subcutaneous dose is $\frac{1}{5}$ to 1 gr. (12 to 60 milligrms.).

Amylocaine Hydrochloride.—$C_{14}H_{21}NO_2,HCl$. (Not official.)

Synonym.—Stovaine.

Cocaine, eucaine (benzamine), and stovaine, when injected inside the spinal dura mater by puncture between the vertebral laminæ, produce, by acting on the posterior nerve roots, sufficient local anæsthesia in all the parts having nerve supply from nerves leaving the spinal cord near the site of injection, for the performance of operations upon them. The injection is usually made in the lumbar region, and more rarely between the first and second dorsal vertebræ. This mode of producing anæsthesia is no safer than general anæsthesia, but if it is employed stovaine is the best of the three, for it is more powerful and only has half the toxicity of cocaine. A sterile aqueous solution containing $\frac{1}{5}$ to 1 gr. (12 to 60 milligrms.) of stovaine may be used, and it is advised that $\frac{1}{150}$ to $\frac{1}{100}$ gr. (0·4 to 0·6 milligrm.) of strychnine be added to it.

KAVA RHIZOME.

Kavæ Rhizoma.—The peeled, dried, and divided root of *Piper methysticum.*

Characters.—Light grey irregular fragments.

Officially used in Australasian Colonies.

Preparation.

Extractum Kavæ Liquidum.—Percolate the powdered rhizome with a mixture of alcohol (90 per cent.) and alcohol (45 per cent.).

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

Action and Therapeutics.

Hypodermic injection of the fluid extract produces anæsthesia at the point of injection, followed by general paralysis due to direct action on the cord, and thus illustrates the two main actions of the drug—viz. depression of the motor function of the cord and of the peripheral ends of sensory nerves. The production of local anæsthesia is due to a resinous constituent called "Kawine," which when placed upon the tongue or skin causes burning pain

followed by local anæsthesia, and this burning pain is so great as to forbid the use of the drug as a local anæsthetic. The fluid extract is given quite empirically, but, it is said, successfully, in gonorrhœa, vaginitis, and leucorrhœa, and also as a diuretic.

"Kava," or "Ava," is the name given to an intoxicating liquid made from the root of *Piper methysticum* in the Sandwich Isles. The intoxication produced differs from that of alcohol in that it is silent and drowsy; there are incoherent dreams and great loss of muscular power.

PILOCARPINE NITRATE.

Pilocarpinæ Nitras.—Pilocarpine Nitrate. $C_{11}H_{16}N_2O_2,HNO_3$.

SOURCE.—The nitrate of an alkaloid obtained from the leaves of *Pilocarpus microphyllus* and other species of *Pilocarpus*. Jaborandi leaves.

CHARACTERS.—A white crystalline powder. Commercial samples frequently contain isopilocarpine and pilocarpidine. *Solubility.*—1 in 8 of water, 1 in 50 of cold, freely in hot alcohol (90 per cent.)

Dose, $\frac{1}{20}$ to $\frac{1}{5}$ gr.—3 to 12 milligrms.—hypodermically.

ACTION.

External.—None.

Internal.—*Gastro-intestinal tract.*—Pilocarpine is very quickly absorbed, and soon produces a great increase in the amount of salivary secretion. The mouth seems warm, and there may be a feeling of tenseness about the salivary glands. The saliva contains an abundance of salts and ptyalin, and can convert starch into sugar. Its increase is due to a direct stimulation of the terminal junctions of the chorda tympani and other nerves which end in the cells of the salivary glands, so that stimulation of these nerves can add little to the flow produced by the drug—in fact, not more than can be accounted for by vascular alterations. This action is antago-

nized by atropine, as that paralyses the junctions of these nerves with the cells (see pp. 82 and 391). In the same manner pilocarpine excites the secretion of the gastric juice, intestinal fluid, and pancreatic secretion. The unstriped muscle of the stomach and intestine is stimulated, and thus the drug may purge. The bile is unaffected. Large doses, especially of jaborandi, may produce vomiting.

Circulation.—Pilocarpine has no effect on the blood, but it is a cardiac depressant. The pulse-rate, it is true, may be, and in the human being always is, a little accelerated at first, but soon it falls. This slowing of the pulse is at once set aside by atropine, but is not prevented by section of the vagus, therefore pilocarpine acts on the heart itself, stimulating the terminal myoneural junctions of the vagus. The arterioles of the limbs and body generally are constricted by action on the nerve ends in the vessel walls, but the pulmonary arterioles are dilated. The vascular constriction and primary cardiac acceleration cause at first a rise of blood pressure, but soon the depression of the heart leads to a fall. The lymphocytes in the blood are increased.

Respiration.—In the same way as with other secretions that of the bronchi is greatly increased, and the bronchioles are constricted from excitation of the vagal endings in the bronchial muscles.

Skin.—Jaborandi, through its alkaloid pilocarpine, produces a very profuse secretion of sweat. It is the most powerful diaphoretic drug we have. A single dose may cause the flow of fifteen fluid ounces of sweat. It is said that the proportion of urea and chlorides in the sweat is greatly increased. This profuse diaphoresis is due to the action of the pilocarpine on the junctions of the nerves in the sweat-glands, and is stopped by atropine. The skin may flush, but this is not the cause of the diaphoresis. Under a course of jaborandi the hair

grows more actively, but it becomes very coarse and dark.

Kidneys.—If the sweating is profuse the secretion of urine is lessened. Pilocarpine is excreted unchanged in the urine, which may contain sugar due to stimulation of the glycogenic function of the liver.

Temperature.—The temperature falls considerably. This is probably due in large part to the evaporation of the perspiration.

Eye.—Whether applied locally to the eye or given internally, pilocarpine produces great contraction of the pupil, due to stimulation of the ends of the third nerve in the eye, and this is antagonized by atropine. It also causes increased tension of the eyeball, and an approximation of the nearest and farthest points of distinct vision, due to contraction of the ciliary muscle.

Other actions.—It stimulates the uterus, and has in very rare cases produced abortion. It increases the secretion of milk, of tears, of nasal mucus, and of cerumen. It causes the spleen and bladder to contract.

It will be noticed that it has two main actions: (1) It stimulates the secretions, viz. those of the salivary glands, stomach, intestines, skin, pancreas, bronchial mucous membrane, nose, lachrymal glands, and ear. In those that have been investigated, and probably in all, it acts locally on the junction between the cells of the glands and the nerve terminations. (2) It stimulates the myoneural junctions of involuntary muscles, viz. in the eye, the intestines, the stomach, the bronchial tubes, the uterus, the spleen, the heart, the bladder, and it acts on the muscular coat of the vessels. The most important effects are the diaphoresis, the salivation, and the myosis. It is consequently antagonistic in its action to atropine, but it is much weaker, for a small dose of atropine

counteracts a very large dose of pilocarpine. Children bear large doses of it well. Pilocarpine is much more used than jaborandi, as it is more prompt and more certain in its action, and is less likely to cause indigestion.

Isopilocarpine has in all respects a similar action to pilocarpine, but it is much less powerful; and so has pilocarpidine, but it is still less active.

Therapeutics.

External.—Pilocarpine has been used locally to promote the growth of the hair. An ointment (Pilocarpine nitrate, 4 gr., 25 centigrms.; vaseline, $\frac{1}{2}$ oz., 16 grms.; lanolin, $\frac{1}{2}$ oz., 16 grms.), and a lotion (Pilocarpine nitrate, 2 gr., 12 centigrms.; quinine hydrochloride, 8 gr., 50 centigrms.; glycerin, 2 fl. dr., 8 mils; aqua rosæ, 6 fl. dr., 24 mils) have been used.

Internal.—Pilocarpine has been employed for many conditions, but its great use is as a diaphoretic in Bright's disease. For this purpose $\frac{1}{5}$ of a grain (12 milligrms.) or more of the nitrate is injected subcutaneously in the evening. The sweating is aided by wrapping the patient, who should be naked, in several warm blankets, giving him hot drinks, and putting a hot water bottle to his feet. After the sweating has ceased, he should be dried and left in a dry blanket. It must be given with great caution when the heart is diseased, for it is a cardiac depressant, and when there is bronchitis for it increases the bronchial secretion. Occasionally it is employed locally in affections of the eye. Patients suffering from deafness, due to disease of the auditory nerve or its terminations, are sometimes relieved by pilocarpine. Injected subcutaneously it has been given successfully as an antidote to belladonna poisoning.

Muscarine.—(Not official.)

Muscarine is an alkaloid extracted from a poisonous mushroom, *Agaricus muscarius*.

It acts exactly like pilocarpine, but is not used in medicine because it is such a very powerful poison.

Agaric Acid. *Synonym.*—Agaricin.—(Not official.)

A white micro-crystalline powder obtained from the white agaric, a fungus growing on the larch tree. It stops sweating by acting on the ends of the peripheral nerves of the sweat glands, but it does not inhibit any other secretions. It is given as a pill in doses of $\frac{1}{10}$ to 1 gr. (6 to 60 milligrms.) to stop the sweating of phthisis. The objection to its use is that it may cause vomiting and diarrhœa.

Curara.—(Not official.)

Synonyms.—Curare, Ourari, Urari, Wourara, Wourali. The South American arrow poison, prepared from the bark of *Strychnos toxifera* and other species of Strychnos.

Characters.—A blackish-brown, dry, bitter extract.

Composition.—It contains an extremely active poison, curarine or curarina, a yellowish-brown powder, intensely bitter.

Dose, $\frac{1}{20}$ to $\frac{1}{2}$ gr.—3 to 30 milligrms.—subcutaneously.

Preparation. (B. P. C.)

Injectio Curaræ Hypodermica.—Curare, 10; sterilized water, 100.

Dose, 1 to 6 m.—6 to 36 centimils (subcutaneously).

Lamellæ or discs, each containing $\frac{1}{20}$ of a grain (3 milligrms.), are also prepared. They are dissolved in a few minims of water before injection subcutaneously.

The physiological action of curare, by which it paralyses the myoneural junction between motor nerves and voluntary muscle, is well known. It has been given, and occasionally successfully, in tetanus.

GROUP II.

Vegetable Drugs whose Main Action is on the Heart.

Class I.—The digitalis group, decreasing the frequency and increasing the force of the beat of the heart:

Digitalis. Strophanthus. Squill. Urginea. Convallaria. Erythrophlœum. Apocynum.

Class II.—The aconite group, decreasing the frequency and decreasing the force of the beat of the heart:

Aconite. Veratrine.

Class I.—The Digitalis Group.

DIGITALIS.

Digitalis folia.—Digitalis Leaves. *Synonym.*—Foxglove Leaves. The dried leaves of *Digitalis purpurea*, the purple foxglove. Collected from plants commencing to flower, thoroughly dried at a low temperature and kept dry in well filled air-tight containers. When powdered no portion should be rejected.

Characters.—12 to 30 centimetres long, up to 15 centimetres broad, with a winged petiole; ovate, subacute, crenate; somewhat rugose, hairy dull green above, densely pubescent and paler beneath. Odour faint. Taste very bitter, unpleasant.

Composition.—The amount and character of the active constituents vary with the season, soil, and parts of the plant used. Preparations deteriorate with age, and the leaves of the cultivated plant contain only half the glucoside contents of the wild leaves. The chief constituents are—(1) Digitoxin, a pentoside, the most active principle, very poisonous, cumulative. Insoluble in water, sparingly in ether, easily in chloroform and alcohol. Exists in commerce as minute white crystals. It is unsuitable for giving by the mouth or subcutaneously, as it is very irritant. (2) Digitalin, a crystalline glucoside possessing the actions of digitalis to half the extent of digitoxin. It is not a commercial product, and when ordered the substance called Digitalin verum Germanicum is

usually supplied. This contains digitalin and digitoxin (*see* below). (3) Digitonin, a saponin (*q.v.*); this is a cardiac depressant, but when given by the mouth it is not absorbed. It is the principal cause of the gastro-intestinal irritation produced by digitalis. It conduces to the solubility of digitoxin and digitalin in the infusion. The following glucosides have been described, but it is uncertain if they are distinct substances. (4) Digitophyllin, a glucoside. (5) Digitalein, an amorphous glucoside, soluble in water, and therefore suitable for hypodermic injections; dose hypodermically $\frac{1}{100}$ gr., said to be non-cumulative. (6) Digitin, a glucoside devoid of physiological action. All these glucosides are non-nitrogenous. (7) Two acids, digitalic and antirrhinic. (8) Other usual constituents of plants, as tannin, volatile oil, colouring matter, starch, sugar, gum, salts. It will be noticed that digitalis contains no alkaloids.

The following substances, all soluble in alcohol, are met with in commerce. Many are prepared from the seeds and are not so reliable as digitalis :—

(A) Homolle's digitalin (same as Quévenne's digitalin), an amorphous yellowish-white powder or small scales, intensely bitter, inodorous, but irritating to the nostrils. Consists chiefly of digitalin with a little digitoxin. Possesses the action of the leaves. Granules of it are used on the Continent; each usually contains $\frac{1}{65}$ of a grain, which is equal to $1\frac{1}{2}$ gr. of the powdered leaves, but they are uncertain in composition.

(B) Nativelle's digitalin : light white crystalline tufts of needles, very bitter. Soluble in chloroform, not in water or ether. It consists very largely of digitoxin, and is cumulative. Dose, $\frac{1}{250}$ to $\frac{1}{60}$ gr. in a pill. This is a popular drug, and is usually given in granules containing $\frac{1}{4}$ milligramme in each.

(C) German digitalinum pulverisatum purum. Dose, $\frac{1}{4}$ to $\frac{1}{2}$ gr. by the mouth; $\frac{1}{60}$ to $\frac{1}{20}$ subcutaneously. A yellowish-white powder. Soluble in water. Consists chiefly of digitalein, with some digitalin and digitonin. It is the most suitable preparation for subcutaneous injection.

(D) Digalen or "Digitoxin solubile," sold as an aqueous solution with glycerin added. Dose by the mouth, 15 ♏. It is mostly digitalein. It is very irritant when injected subcutaneously, and is for no purpose superior to the pharmacopœial preparations.

(E) Digipuratum. This is said to cause less irritation than any digitalis preparation, and is, therefore, often of use. It is sold as tablets, containing 0·1 grm. Three or four to be given daily.

(F) Digitalone, not much used.

Incompatibles.—Per-salts of iron (*see* p. 450), lead acetate, cinchona.

Dose, ½ to 2 gr.—3 to 12 centigrms. of the powdered leaves. Subcutaneous administration of digitalis is not recommended, as being irritant.

Preparations.

1. Infusum Digitalis. — Digitalis leaves, 7; boiling water, 1000 (contains much digitonin, not much digitoxin). If kept long loses its physiological activity.

Dose, 2 to 4 fl. dr.—7 to 15 mils (note that it is drachms, not ounces).

2. Tinctura Digitalis.—Digitalis leaves, 1; alcohol (70 per cent.), 10. Percolate. (Contains both digitalin and digitoxin.) Deteriorates with keeping.

Dose, 5 to 15 m.—3 to 10 decimils.

This is four-fifths the strength of the corresponding preparation, B. P. 1898.

As the proportion of the many constituents varies in the preparations, doses much larger than those just mentioned may often be given, and some prefer always to give the powdered leaves, but probably digitalis acts best when the recently prepared tincture is used. This loses efficacy if long in contact with water, therefore the prescribed dose should be dropped into water immediately before being swallowed.

Action.

External.—The leaves are slightly irritating, but it is doubtful whether any of their constituents can be absorbed by the skin. Preparations of digitalis occasionally cause abscesses if injected subcutaneously.

Internal.—*Gastro-intestinal tract.*—Digitalis is a **mild gastro-intestinal irritant**, and even moderate doses may cause diarrhœa and vomiting due to stimulation of the medullary centre.

Blood.—It is somewhat slowly absorbed; it is not known to affect the blood.

Heart.—The first action of digitalis in mammals is to slow the beat of the heart, by prolonging the diastole, the duration of the systole is not altered, but its force is greatly increased, so much so that after large doses the heart may, in animals, be seen to become pale, because almost every drop of blood is squeezed out of it. The pulse is consequently increased in force, but retarded. If before the drug was given the heart was beating irregularly, it generally becomes regular. If the drug is taken internally, the whole of both ventricles is, in mammals, affected; but in frogs one portion of the ventricle may remain spasmodically contracted during the diastole of the rest of it. After toxic doses the contractions are very irregular, and finally the ventricles are in frogs arrested in systole, firmly contracted, quite pale, and unable to respond to any stimuli, but in mammals the heart finally stops in diastole. In frogs the slowing is due to a prolongation of systole, not diastole, for in them the direct action on the muscle is greater than that on the vagus mechanism; but the latter predominates in mammals, hence the lengthening of diastole. If locally applied to parts of the ventricle of the frog, only those parts to which the digitalis is applied are contracted; this is not so in mammals. The auricles are in most animals slowed by it, but the force of their beat is not much altered, because their muscular mechanism is much less developed than their vagal. In all animals large doses cause great irregularity of the auricular beat.

That these phenomena are partly due to the direct action of the drug on the cardiac muscle is shown by the fact that digitalis not only tonically contracts the frog's heart when applied locally, but it will even increase the force of the contraction when applied to the isolated apex in which it is believed no nerves exist, and it acts on the embryonic heart of

the chick before the nerves are developed. Further, in warm-blooded animals, although digitalis does not retard the pulse if the vagi have been cut, although it increases the force of the cardiac beat, yet if the vagi are intact the pulse is greatly slowed, therefore the vagus centre in the medulla must have been stimulated to a considerable extent, and this is the cause of the slowing of the heart by digitalis in warm-blooded animals and in man. These two actions, stimulant directly to the cardiac muscle and the vagal centre, affect both auricles and ventricles. Cushny has shown that the vagal action, with most of the digitalis group of drugs, begins a little before the muscular.

It has been proved that small doses actually increase the amount of work done by the heart in a given time, thus there is a greater output at each ventricular contraction. This, indeed, must follow, for as the diastole is prolonged, the ventricular dilatation is excessive, so at the commencement of systole there is an abnormally large amount of blood in the ventricle, which, owing to increased ventricular force, is sent forward into the aorta. Doses larger than those used therapeutically slow the beat from excessive vagal action, larger still accelerate it greatly from excessive action on the muscle which the vagus can no longer control. Some of the benefit of digitalis is due to improved circulation through the coronary arteries.

Vessels.—In man, therapeutic doses of digitalis do not affect the vessels and the blood pressure rises very little if at all, but in animals large doses contract vessels by direct action of the digitalis in the blood on them and the pressure rises considerably. With toxic doses the irritation of the muscular coat of the arterioles passes on to depression, and the blood-pressure falls.

Kidney.—In healthy men and animals digitalis

produces slight diuresis, in patients with heart disease it is generally a powerful diuretic. It acts by improving the circulation of blood through the kidneys.

Excretion.—Digitalis is excreted by the gut and the kidneys. This takes place more slowly than absorption, so that the drug is cumulative.

Temperature.—Moderate doses have no influence on the temperature, but toxic doses cause it to fall.

Respiration.—This is unaffected by small, but large doses increase the frequency and depth of respiration by stimulating the respiratory centre.

Nervous system and Muscles.—With medicinal doses the only effect on the nervous system, beyond stimulation of the vagal centre, is vomiting due to stimulation of the medulla. Large doses may cause headache, giddiness, and disturbances of sight and hearing, and sometimes all objects have appeared blue. These changes are not due to alterations in the cerebral circulation, as was formerly thought. Digitalis directly paralyses muscles if given in toxic doses.

Uterus.—This organ is said to be stimulated to contract by digitalis.

THERAPEUTICS.

External.—Digitalis is not used externally.

Internal.—It is one of the most valuable drugs we have. It is chiefly given in cases of cardiac disorder.

Mitral constriction and regurgitation.—It is common for the mitral valve to be distorted by chronic inflammation so that mitral constriction or regurgitation or both are present. When patients thus affected are seriously ill the disease of the valve is often associated with auricular fibrillation, a condition in which the regular beats of the auricle are replaced by numerous small irregular beats starting inco-ordinately from many parts of the

auricle. The auriculo-ventricular bundle transmits these irregular feeble impulses, but not as quickly as they are formed, and so the ventricular contraction and therefore the pulse is irregular and weak, and although rapid is not so rapid as the auricular contraction.

It has been known for many years that digitalis *succeeds best when the pulse is rapid, feeble, and* irregular; and now we know that it is when this condition of pulse is due to auricular fibrillation that digitalis acts so well that it may be regarded as a specific, causing the ventricular contractions and hence the pulse to become slow, regular, and strong. But the auricle continues to fibrillate, and Cushny has shown that the improvement is not due to the action of digitalis on the vagus mechanism, but to its direct action on the tissues of the heart which convey impulses from the auricle to the ventricle, so that, under digitalis, only a few of the numerous auricular impulses are allowed to pass to the ventricle and these regularly, this therefore gets a proper rest between each beat, and the pulse is regular, slower, and stronger.

Experimentally this effect of digitalis is not seen when auricular fibrillation is produced in a heart *in situ*, but is seen in auricular fibrillation produced in the perfused heart. Now this receives no source of energy except inorganic salts, and is very short of oxygen; and Cushny suggests that digitalis acts so well in cases associated with auricular fibrillation because in them the heart is like the perfused heart, in a state of malnutrition; but, as he points out, this cannot be the whole explanation, for digitalis acts immensely better when auriculo-fibrillation is present than when the heart is simply debilitated. However, be the explanation what it may, digitalis has a specific action on the conducting tissue of the heart when auricular

fibrillation is present. This is by far its most beneficial action in cases of mitral disease, but its effects on the cardiac muscle and vagus mechanism (described on pp. 442–444) are perhaps helpful.

As it causes the left ventricle to contract more forcibly and regularly, the mitral flaps will be better approximated, the regurgitation will be less, and more blood will be sent on into the arterial circulation. The slowing will also be of great advantage, for the longer diastole will allow more time for the blood to flow from the dilated auricle, and from the right side of the heart and venous system generally, into the left ventricle. In mitral disease, dyspnœa, lividity, venous engorgement of the lungs, of the right side of the heart, of the liver, the kidneys, and œdema of the subcutaneous tissues are very common. Digitalis, by improving the venous flow, will ameliorate all these. It has been supposed that by constricting all the peripheral arterioles it would impede the arterial flow because the heart will have to contract against a greater peripheral resistance, but we have seen that therapeutic doses of digitalis do not constrict the vessels in human beings. If, as it usually does in these cases, digitalis acts as a diuretic, this will be of help in removing the œdema, and in causing the scanty high-coloured urine to become pale and abundant. The improvement in the circulation relieves the cardiac pain and distress which so commonly accompany mitral disease, the lividity passes off, the dyspnœa decreases, and usually in a day or two a wonderful improvement in the patient's condition takes place. The less any case of mitral disease is accompanied by auricular fibrillation, the less good, as a rule, will digitalis do. Sometimes the vomiting caused by it prohibits its use. Fatal syncope may occur in those taking digitalis if they are too suddenly raised from the prone to the upright posture.

It is a common error to give too little digitalis, some cases of cardiac disease are not benefited by less than doses of 30 minims (2 mils) of the tincture, and sometimes no good follows until the drug has been given for some days.

Disease of the tricuspid valve.—In both tricuspid constriction and tricuspid regurgitation digitalis will be beneficial in the same way as in similar affections of the mitral valve. As a rule, however, it does less good when the disease is on the right side of the heart.

Aortic regurgitation.—Often digitalis is harmful, for by prolonging the diastole more time is allowed for the blood to fall back through the imperfectly closed aortic orifice, and hence there is great danger of fatal syncope. The drug should only be given in cases of aortic regurgitation when the heart is rapid, or when there is evidence that not much blood regurgitates, or when there are reasons, such as the coincident presence of aortic obstruction, for wishing to strengthen and regulate the contraction, but then it may do much good. The dose must be small and the effects must be carefully watched.

Aortic obstruction. — This, unfortunately, is usually accompanied by aortic regurgitation; but sometimes when it is wished to increase the force of the beat, and so to drive more blood through the constricted aortic orifice, digitalis is useful, or when auricular fibrillation accompanies aortic disease.

Bright's disease.—In cases of contracted granular kidney in which the associated cardiac condition has progressed so far that the case resembles one of primary mitral disease, digitalis is of service. A diuretic pill (commonly known as Guy's pill), often used for this condition, consists of mercurial pill, digitalis leaves, and squill, a grain of each, made up with extract of henbane. In the earlier stages of acute Bright's disease it has been

given as a diuretic, but it is questionable whether it is right to increase the flow through an acutely inflamed organ; further, digitalis is always, unless the heart is diseased, an uncertain diuretic. In chronic tubal nephritis uncomplicated by cardiac disease it is worse than useless, for it has no effect on the renal cells.

Diseases of the cardiac muscle.—If the heart be fatty or otherwise degenerate, digitalis rarely does good. The weakly acting heart that is met with during pericarditis, pneumonia, typhoid fever, scarlet fever, rheumatism, and other acute diseases, even if no valvular defects are present, is often greatly strengthened by digitalis. For this purpose it may be combined with caffeine, or two drachms of the infusion may be given, with three minims of strong solution of ammonia, in a little water. Each contraction is made more efficient, and the prolonged diastole allows more time for the muscle to rest. It is clear that in the course of twenty-four hours this additional repose, although but little in each cycle, will amount to a considerable time. Many men who have practised rowing or other hard exercise to excess suffer from shortness of breath, and the apex of the heart is found to be a little outside the normal position, but there is no demonstrable valvular lesion. This condition, which also occurs in soldiers after a long campaign, is benefited by digitalis. The dilatation of the right side of the heart that so frequently accompanies chronic disease of the lungs may be, but is not usually, improved by digitalis.

Functional disease of the heart.—The irregular palpitating beat, often seen apart from any organic disease, is rarely benefited by digitalis, for it is commonly a result of indigestion, in which case the right treatment is, if possible, to cure the dyspepsia, and digitalis may excite indigestion. The functional

affections of the heart met with in highly neurotic subjects may be, but are not often, benefited by digitalis.

Exophthalmic goitre may improve by long use of digitalis; but generally this treatment fails.

Hæmorrhage.—Digitalis was formerly given as a hæmostatic, but is now discarded as it is of no use.

Alcoholism.—Moderate doses of digitalis have been said to be serviceable in chronic alcoholism on account of their stimulating effect on the circulation. Enormous doses have been given empirically in delirium tremens, but generally without any good result.

Uterus.—Because of its power to contract the uterus digitalis may be useful in menorrhagia.

It is often desirable to combine fluid preparations of digitalis with salts of iron; the resulting mixture, which is usually inky from the action of the iron on the tannin in the digitalis, can be clarified by the addition of a little citric acid. Because of this difficulty the powdered digitalis leaves are often made into a pill with dried sulphate of iron.

Antagonisms.

Antagonism between digitalis and aconite.—Aconite is a cardiac poison, weakening instead of strengthening the beat; it dilates the peripheral vessels, it lowers the blood-pressure, and after death the heart is always found in a condition of diastole. In all these points it is antagonistic to digitalis. The action of aconite is very rapid, that of digitalis very slow. Therefore these drugs are not practical antidotes to each other in poisoning.

Scoparin is also physiologically antagonistic to digitalis.

Digitalis is **cumulative.** Patients who have taken it for a long while sometimes suddenly show symptoms of poisoning without any increase in the dose. This is because, as the drug is not excreted by the kidneys as fast as it is absorbed, it accumulates in the body, chiefly in the cardiac muscle. Those taking it constantly should generally omit it one week in every four. The most important symptom of poisoning is slowing of the pulse, but the most common is vomiting, and this often prevents its administration, but is least likely, it

is said, to occur when the preparation used is given uncombined with other drugs. The irregular appearance of vomiting is sometimes due to the varying strength of the preparations (*see* Physiological Standardization, p. 9).

STROPHANTHUS.

Strophanthi Semina.—The dried ripe seeds of *Strophanthus kombé* freed from awns. Equatorial West Africa.

Characters.—Oval-acuminate, greenish fawn, covered with appressed silky hairs, about 15 millimetres long, 4 millimetres broad, base blunt, apex tapering, sides flattened, one side has a ridge from centre to apex, dorsal surface convex. Kernel white and oily, consisting of a straight embryo with two thin cotyledons surrounded by their albumen. Odour characteristic. Taste very bitter.

Composition.—The chief constituents are—(1) *Strophanthin*, $C_{40}H_{66}O_{19}$. This is the active principle. It exists in all parts of the plant, but mostly in the seeds (8 to 10 per cent.). It is bitter and occurs as a transparent, white, crystalline or as a pale yellow amorphous glucoside (being split up by acids into glucose and strophanthidin). Insoluble in chloroform and ether, soluble in water. (2) Kombic acid. (3) Inein, an active principle.

Strophanthin is more suitable than digitalis derivatives for intravenous use. Dose $\frac{1}{500}$ to $\frac{1}{100}$ gr. in normal saline. It may cause abscesses if given subcutaneously or intramuscularly.

Preparations.

1. **Extractum Strophanthi.**—Dried powdered strophanthus seeds are percolated with ether, dried, percolated with alcohol, dried, and diluted with milk sugar.

Dose, $\frac{1}{4}$ to 1 gr.—16 to 60 milligrms.

2. **Tinctura Strophanthi.**—Dried strophanthus seeds, 1; ether, q.s.; alcohol (70 per cent.), 10. Percolate.

Dose, 2 to 5 m.—12 to 30 centimils.

This is made with four times the proportion of strophanthus seeds ordered for the corresponding preparation of the B. P. 1898. It is best given dropped in water immediately before being taken.

Action.

External.—None.

Internal.—*Gastro-intestinal tract.*—Like digitalis, strophanthus is liable to cause vomiting and diarrhœa, especially if the dose be large. In small doses its bitter action may come into play, and then it will aid digestion like any other bitter stomachic.

Heart.—Strophanthus acts on the heart of mammals exactly like digitalis, for it strengthens the force of the systole, prolongs the diastole, consequently slows the rate of the beat, and makes an irregular heart regular. The details of its cardiac action are the same as those of digitalis.

Vessels.—It does not constrict the peripheral vessels, or at any rate very slightly; therefore, any rise of blood-pressure is almost entirely due to the action of the drug on the heart.

Kidneys.—Its action is the same as that of digitalis.

Nervous system.—This is not affected. In toxic doses it is a direct poison to the voluntary muscles. Strophanthin is a powerful local anæsthetic when dropped on the conjunctivæ.

Respiration.—No particular effect is produced.

The African Kombé arrow poison is made from strophanthus.

Therapeutics.

Strophanthus has precisely the same specific effect in auricular fibrillation and is used in the same varieties of cardiac disease as digitalis, and is therefore chiefly valuable in cases of auricular fibrillation in mitral disease. In the treatment of a case of heart disease, digitalis is usually given first; but if the patient does not improve on this, then strophanthus

may be tried. It will sometimes happen that strophanthus will not produce vomiting when digitalis does, but there are many individual differences. Digitalis is usually given when a diuretic effect is desired. Strophanthus is not cumulative. It has been recommended in exophthalmic goitre. Probably other seeds than strophanthus seeds are often sold as such, hence the efficacy of the preparations is variable.

Strophanthin is successfully used intravenously in urgent cases of cardiac failure.

SQUILL.

Scilla.—Squill. The bulb of *Urginea scilla*, divested of its dry, membranous, outer scales, cut into slices and dried. When powdered should be kept quite dry over quicklime. Mediterranean coast.

CHARACTERS.—The slices of the inner scales are curved, yellowish-white or pinkish, translucent strips, 1 to 2 in. long. Odour none. Taste very bitter. Easily pulverizable if dry, not if wet.

COMPOSITION.—The chief constituents are—(1) *Scillitoxin*, or scillin, a glucoside, the most active principle. (2) Scillipicrin, also active, and closely related to scillitoxin.

Dose, 1 to 3 gr.—6 to 20 centigrms.

Preparations.

1. **Acetum Scillæ.**—Squill, 10; acetic acid, 10; distilled water, 32. Macerate.

Dose, 5 to 15 m.—3 to 10 decimils.

This is approximately twice the strength of Acetum Scillæ, B. P. 1898.

2. **Oxymel Scillæ.**—Vinegar of squill, 200; purified honey, 500.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

3. **Syrupus Scillæ.**—Acetum Scillæ, 175; sugar, 650; water, to 1000.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

4. **Pilula Ipecacuanhæ cum Scillâ.**—Squill, 1; compound ipecacuanha powder, 3; ammoniacum, 1; syrup of glucose, q.s. *Strength of opium*, 5 per cent.

Dose, 4 to 8 gr.—25 to 50 centigrms.

5. **Pilula Scillæ Composita.**—Squill, 25; ginger, 20; ammoniacum, 20; hard soap, 15; syrup of glucose, 20.

Dose, 4 to 8 gr.—25 to 50 centigrms.

6. **Tinctura Scillæ.**—Squill, 2; alcohol (60 per cent.), 10. Macerate.

Dose, 5 to 15 m.—3 to 10 decimils.

Action.

Squill so closely resembles digitalis in its action that the account of that drug will apply to squill with the following additions. Many believe that squill is a more powerful gastro-intestinal irritant; and that vomiting and purging result from even moderate doses, but often this is not so. In the second place, some constituent of squill is excreted by the bronchial mucous membrane, and irritates it. The vascularity and the amount and fluidity of secretion are thereby increased. Squill is, therefore, an expectorant. Thirdly, squill in the course of its excretion through the kidneys stimulates them; it is, therefore, a more energetic diuretic than digitalis, and it may irritate the kidneys excessively.

Therapeutics.

Because of its irritating properties squill is not given alone, but it is frequently combined with digitalis when that drug is administered for heart disease or as a diuretic. A very favourite diuretic pill is composed of powdered squill, powdered digitalis leaves and blue pill, 1 grain (6 centigrms.) of each, made up with some simple vehicle.

Squill is much used as an expectorant, but it is always prescribed in combination; it is too irritating to the bronchial mucous membrane for it to be given in acute bronchitis; nor should it be chosen in phthisis, lest it should cause dyspepsia; but it is valuable in chronic bronchitis if the secretion is scanty.

Squill should not be given in acute Bright's disease, for it is too irritating to the kidneys.

INDIAN SQUILL.

Urginea.—The younger bulbs of *Urginea indica*, taken soon after the plant has flowered, divested of their dry, outer, membranous coats, cut into slices and dried. When powdered should be kept dry over quicklime.

CHARACTERS.—Curved or sickle-shaped strips, separated or connected, several together, to a portion of the shortened axis. Yellowish white, no odour, taste bitter.

Dose, 1 to 3 gr.—6 to 20 centigrms.

Preparations.

1. **Acetum Urgineæ.**—Urginea, 10; acetic acid, 10; distilled water, 32. Macerate.

Dose, 5 to 15 m.—3 to 10 decimils.

This preparation is twice the strength of the Acetum Urginea of the Indian and Colonial Addendum, 1900.

2. **Oxymel Urgineæ.**—Vinegar of Urginea, 200; purified honey, 500.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

3. **Pilula Ipecacuanhæ cum Urginea.**—Compound ipecacuanha powder, 3; urginea, 1; ammoniacum, 1; syrup of glucose, q.s. *Strength of opium* 5 per cent.

Dose, 4 to 8 gr.—25 to 50 centigrms.

4. **Pilula Urgineæ Composita.**—Urginea. 25; ginger, 20; ammoniacum, 20; hard soap, 15; syrup of glucose, 20.

Dose, 4 to 8 gr.—25 to 50 centigrms.

5. Syrupus Urgineæ.—Vinegar of urginea, 175; refined sugar, 650; water to 1000.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

6. Tinctura Urgineæ.—2 in 10 of alcohol (60 per cent.). Macerate.

Dose, 5 to 15 m.—3 to 10 decimils.

Action and Therapeutics.

Urginea has precisely the same action and use as squill. It is used chiefly in India and the East.

Convallaria Majalis.—(Not official.)

The lily of the valley. The entire plant is used.

Characters.—Leaves 4 to 6 in. long, radical, oblong, tapering. Flower stem leafless, radical, shorter than the leaves. Flowers white, bell-shaped, drooping, forming a loose raceme.

Composition.—The chief constituents are—(1) Convalla marin, a glucoside, the active principle. (2) Convallarin, a glucoside, said only to purge.

Preparation (B. P. C.).

Tinctura Convallariæ.—The flowers, 1; alcohol (60 per cent.), 8.

Dose, 5 to 20 m.—3 to 12 decimils.

The action of Convallaria Majalis is probably precisely that of digitalis, and it may be given in exactly the same varieties of heart disease. It is sometimes successful when digitalis has failed. It is not so powerful as digitalis, but some find it less likely to produce sickness.

Erythrophlœum.—(Not official.)

Casca Bark.—*Synonyms.*—Sassy bark; Ordeal bark. The bark of *Erythrophlœum guineense* Africa.

Composition.—The active principle is erythrophlœine, an alkaloid.

Preparation (B. P. C.).

Tinctura Erythrophlœi.—Sassy bark, 1; alco hol (90 per cent.), 10.

Dose, 5 to 10 m.—3 to 6 decimils.

The action of erythrophlœum is much the same as that of digitalis, and it may be used for the same class of cases. It is, however, more likely to cause vomiting, and the action on the inhibitory vagal mechanism is much more marked than that on the cardiac muscle.

Apocynum.—(Not official.) *Synonym.*—Canadian Hemp. The rhizome of root of *Apocynum cannabinum.*

Composition.—It contains a crystalline body, apocynin, which is inert, and an active principle, cynotoxin or apocynamarin.

The action of Apocynum is much the same as that of the other members of the digitalis group, except that it is often a considerable gastro-intestinal irritant; it contracts the vessels more than digitalis but does not act on the kidney directly. It is usually given as a tincture (B. P. C.). **Dose 5 to 10 m.—3 to 6 decimils.**

Class II.—The Aconite Group.

ACONITE.

Aconiti Radix.—Aconite Root. The dried root of *Aconitum napellus.*

Characters.—Usually 4 to 10 centimetres long. Upper extremity is 1 to 2 centimetres in diameter; conical, shrivelled, shows scars of broken rootlets; dark brown externally, whitish internally. Has a central axis with rays. Cautiously chewed, produces after some minutes tingling and numbness. Yields not less than 0·4 per cent. of ether-soluble alkaloids. Resembles horseradish (*see* p. 547).

Composition.—The chief active principle is the alkaloid *aconitine* (*see* p. 458). Two other alkaloids are present, viz. aconine and benzaconine. Some commercial specimens of aconitine consist chiefly of these, which are much less powerful.

Preparations.

1. **Linimentum Aconiti.**—Powdered root, 500; camphor, q.s.; alcohol (90 per cent.), q.s. *Strength.*—0·2 per cent. or 0·2 grm. in 100 millilitres.

2. Tinctura Aconiti.—Powdered root, 1; alcohol (70 per cent.), q.s. Percolate. *Strength.*—This contains 0·04 grm. of ether-soluble alkaloids in 100 millilitres.

Dose, 2 to 5 m.—12 to 30 centimils.

It is twice as strong as the corresponding preparation, B. P. 1898.

Aconitina.—Aconitine. $C_{34}H_{45}NO_{11}$.

Source.—An alkaloid obtained from aconite root.

Characters.—Colourless, hexagonal prisms of the rhombic system. Melting-point, 198°C. Produces tingling when placed on tongue. Its salts are crystalline. Its solutions acidulated with acetic acid give a red crystalline precipitate on addition of potassium permanganate. By partial hydrolysis aconitine forms benzaconine, and on further hydrolysis it forms aconine and benzoic acid. *Solubility.*—Readily in alcohol and chloroform, less so in ether; nearly insoluble in water.

Preparation.

Unguentum Aconitinæ.—Aconitine, 1; oleic acid, 8; prepared lard, 41.

In India prepared suet should be used instead of prepared lard.

Action.

The action of aconite, which has been restudied by Cash and Dunstan, is due chiefly to the aconitine in it, and therefore they may be considered together. (For Benzaconine and Aconine *see* p. 460.)

External.—Applied to the skin, to a mucous membrane, or to a raw surface, aconitine, and therefore aconite, first stimulates and then paralyses the sensory nerves; it thus causes first tingling, then numbness and local anæsthesia for touch, pain, and temperature, which last some time. Unless the skin is sound a dangerous quantity may be absorbed. It is intensely irritant to the nostrils, causing, when it is inhaled, sneezing and much secretion with an icy cold sensation.

Internal.—*Gastro-intestinal tract.*—Numbness and tingling are produced in the mouth and a greatly increased flow of saliva. There are no other gastro-intestinal symptoms provided the dose is not very large; if it is, there may be vomiting and purging.

Heart.—With small doses the rate of the beat is, according to some, slowed. Others say they have no effect. If more is given the force and tension become less, and the pulse is slowed from stimulation of the vagus centre. But after larger doses the pulse quickens, misses beats, and becomes irregular. Many of the ventricular beats have no corresponding auricular contraction, although the two auricles always contract together and the two ventricles always contract together. As the irregularity and frequency of ventricular contractions increase, the blood-pressure rapidly undergoes great variations. It is not until quite the end of its action that aconite influences the heart muscle. The ventricles, always more affected than the auricles, pass into a condition of delirium. Moderate doses lead to a fall of blood-pressure, almost entirely secondary to the action on the heart or its nerves. The vaso-motor centre is only slightly affected.

Respiration.—This, after a transitory quickening, is steadied and slowed, expiration being considerably prolonged. The movements become more slow and dyspnœal, the respiratory centre is then powerfully depressed, but it is not easy to decide whether death is due to this or to cardiac failure.

Nervous system.—It appears clear that aconite, whether given internally or applied locally, depresses the activity of the peripheral terminations of the nerves; the nerves of common sensation and temperature are affected long before the motor. Any pain that may be present is relieved. Large doses in man cause clonic convulsions, chiefly respiratory.

Later on the paralysis of the motor nerves gives rise to muscular weakness. It is doubtful whether the cord is influenced. The cerebrum is not. The pupil is dilated.

Temperature.—Aconite causes a febrile temperature to fall. This is in part due to its action on the circulation and respiration, but probably other causes are at work.

Skin.—Aconite is a mild diaphoretic; in this case also we do not understand how it acts. Occasionally it produces an erythematous rash.

Kidneys.—It is said to be a feeble diuretic, but its effect is very slight. Aconitine is excreted in the urine.

Benzaconine is bitter, and does not cause tingling or numbness of mucous surfaces; in large doses it slows the pulse-beat very strikingly because the auricular beats are frequently not followed by ventricular contraction. Its action is probably chiefly on the heart muscle itself. It does not paralyse sensory nerves, but greatly interferes with motor nerves and causes a semi-comatose condition. The fall of temperature produced by it is very slight. It will be noticed that it is in almost all respects contrary in action to aconitine.

Aconine is bitter, but does not produce numbness. It is non-toxic as regards the heart, and opposes the cardiac incoordination and asequence caused by aconitine. It depresses motor nerves and respiration very strikingly, probably acting like curare.

It is worth noting that, whilst the introduction into aconitine of two additional acetyl groups (as in diacetyl-aconitine) gives rise to a derivative very similar in action to aconitine, the loss of the acetyl group, as in benzaconine, almost entirely abolishes all physiological resemblance to aconitine. On the other hand, the removal of the benzoyl radical from benzaconine (aconine remaining) produces much less

alteration in action although it does diminish the toxicity of benzaconine. Indaconitine, Pseudaconitine, and Bikhaconitine are alkaloids derived from Indian aconite.

THERAPEUTICS.

External.—As aconite produces local anæsthesia, it is applied externally and often with great benefit in cases of neuralgia, especially facial neuralgia. Frequently it fails, and we cannot tell beforehand whether it will succeed. A small piece of the ointment may be rubbed in till numbness is produced, but as this is a very expensive preparation it is usually better to paint on the liniment with a camel's-hair brush. The pain of chronic rheumatism is sometimes relieved by aconite. Chloroformum Aconiti (a B. P. C. preparation) and Linimentum Aconiti Compositum, commonly called A.B.C. Liniment, because it contains equal parts of Aconite, Belladonna, and Chloroform liniments, are excellent preparations for external use. Aconite should never be used externally unless the skin is quite sound. Collodium Anodynum (B. P. C.), often called Anodyne Colloid, is useful for relieving pain. It contains aconitine and veratrine dissolved in acetone collodion. Sciatica and neuralgia are benefited by it.

Internal.—Aconite may be given internally for neuralgia, but it does not succeed nearly so well as when applied externally. It is not used internally so much as formerly, when it was administered in almost every febrile disease, with the object of decreasing the force and tension of the pulse. It was said to do this very effectually, but Price did not find that it reduced the rate of the pulse in some patients he examined; the reason why it is not so popular at the present time is that it is not now thought desirable to reduce the

force and frequency of the heart in these diseases. Perhaps it is used too little, for many believe that the milder febrile diseases, such as tonsilitis, laryngitis, or a common cold, are distinctly benefited by aconite, especially if they occur in children. In addition to retarding the pulse it increases perspiration and lowers the temperature. As large doses diminish the force of the heart, it is usually given in doses of two or three minims of the tincture every hour or so till the pulse falls to nearly normal; for the same reason it is not advisable to use it for prolonged fevers, as typhoid, nor when the heart is diseased, except in the few cases in which there is sufficient compensative cardiac hypertrophy. In such cardiac cases it is sometimes useful to slow the pulse, even when there is no fever. It will occasionally relieve the pain of aneurysm. A common practice was to combine with it one or two drops of Vinum Antimoniale, as that has much the same action on the heart.

Toxicology.

The symptoms come on quickly; in a few minutes there is a severe burning, tingling sensation in the mouth, followed by numbness. Vomiting begins in an hour or so, and is very severe. There is an intense abdominal burning sensation. The skin is cold and clammy. Numbness and tingling with a sense of formication of the whole skin trouble the patient very much. The pupils are dilated, the eyes fixed and staring. The muscles become very feeble, hence he staggers. The pulse is small, weak, and irregular. There is difficulty of respiration. Death takes place from asphyxia, or in some cases from syncope. The patient is often conscious to the last. *Post mortem.*—The usual signs of death from asphyxia are seen.

Treatment.—Wash out the stomach promptly; give emetics (p. 145). Use artificial respiration early. Inject stimulants, as ether or brandy, subcutaneously. Atropine and the tincture of digitalis should be given by mouth or subcutaneously. Hot blankets and bottles.

Veratrine.—(Not official.)

Veratrine, an alkaloid or mixture of alkaloids obtained from cevadilla, the dried ripe seeds of *Schœnocaulon officinale*. It usually consists of veratrine and slight admixtures of two other alkaloids, cevadine and cevadilline.

Source.—Prepared from cevadilla by precipitation with ammonia.

Characters.—A pale grey amorphous powder. Odour none, but very irritating to the nostrils. Taste very bitter and acrid. *Solubility.*—1 in 6 of ether; 1 in 3 of alcohol (90 per cent.); readily in dilute acids; very feebly in water.

Dose, $\frac{1}{64}$ to $\frac{1}{16}$ gr.—1 to 4 milligrms.—in pill.

Pure veratrine, $C_{37}H_{51}NO_{8}$, crystallizes in rhombic prisms but the veratrine usually seen is very rarely pure.

Action.

External.—Veratrine if it is applied to the unbroken skin, and especially if it is rubbed in, produces tingling and numbness, followed by a sensation of coldness and anæsthesia to pain, touch, and temperature. Given subcutaneously, it causes violent pain and irritation.

Internal.—*Gastro-intestinal tract.*—Inhalation of the minutest portion causes great irritation of the mucous membrane of the nose, violent sneezing, and a free discharge of mucus, which may be bloody. A speck on the tongue gives rise to burning pain and profuse salivation. In the stomach and intestine it produces great epigastric pain, vomiting, and diarrhœa. These results also occur if it is given subcutaneously.

Blood.—Veratrine is quickly absorbed. It is not known to affect the living blood, but it kills the white corpuscles in drawn blood.

Heart.—It acts directly on the cardiac muscle as it does upon voluntary muscle: that is to say, the contractions of the heart become fewer, but each lasts a very long while until ultimately the

heart stops in systole. It also acts on the vagus as on spinal nerves, the functional activity being first exalted, and this is partly the reason of the slowing of the heart; afterwards the vagus is depressed, but this does not cause a quickening of the pulse, because of the action of the veratrine on the cardiac muscle. but it may make the beat irregular. The blood-pressure at first rises from the increased force of the beat, but as the heart slows it falls. The muscular action is most evident in frogs, the vagal in mammals.

Respiration.—Small doses quicken respiration, large ones retard it, producing long pauses, and finally arresting it. These results are probably due at first to stimulation, and afterwards to paralysis of the ends of the vagus in the lung, and to paralysis of the respiratory centres. The temperature is lowered.

Nervous system.—The brain is unaffected, and probably veratrine has no influence on the spinal cord. Motor nerves are first excited and then paralysed by large doses, and the same is true of sensory nerves and their endings in smaller doses, but here the primary stimulation is more marked, hence the transient pain produced by local inunction.

Muscles.—The effect of veratrine is peculiar and characteristic. In animals to which it has been given, or in excised muscles to which it is applied, it is found that the period during which a single contraction lasts is enormously prolonged. If a tracing of the contraction be taken it will be seen that the time of the ascent of the curve is unaltered, that the height is greatly increased and the descent is extraordinarily extended. This is a genuine lengthened contraction, which is neither rigor nor tetanus, but it almost exactly resembles the contraction of the muscles met with in Thomsen's disease. This effect of veratrine disappears if the muscle is cooled.

Therapeutics.

External.—Veratrine has been used as an inunction for neuralgia, and sometimes it succeeds admirably, generally in the same class of cases as are benefited by the local application of aconite.

Internal.—It is rarely given internally, as it has such a powerful and peculiar action on the heart.

GROUP III.

Vegetable Drugs employed for their Action on the Respiratory Organs, and not falling among Volatile Oils (q.v.).

Senega, Ipecacuanha, Lobelia, Virginian Prune.

The first three are gastro-intestinal irritants. Senega and ipecacuanha are both excreted by the bronchial mucous membrane, which they irritate. Group II. is connected with this group by senega, which acts on the heart like squill, and squill like senega is excreted by the bronchial mucous membrane.

SENEGA.

Senegæ Radix.—The dried root of *Polygala senega*. From North America.

Characters.—Slender roots 5 to 10 centimetres long, of which the upper end is an irregular knotty tuberosity with remains of small stems, tapering below into a tortuous wrinkled keeled root, $\frac{1}{5}$ to $\frac{1}{2}$ in. thick. Bark yellowish or brownish grey, transversely cracked. Fracture short and brittle. Odour of bark peculiar and rancid, its taste at first sweetish, but afterwards very sour, and causing a flow of saliva. Central column woody, tasteless, and inodorous. *Resembling senega root.*—Arnica, Valerian, Serpentary, and Green Hellebore, but none of these have a keel.

Composition.—The chief constituents are—(1) Senegin, a glucoside, is the active principle, is identical with Saponin, found in Saponaria (Quillaia bark, *q.v.*), and many other

plants. Saponin is decomposed by hydrochloric acid into sugar and sapogenin. It exists as a white powder, which forms a soapy emulsion when mixed with water. (2) Polygalic acid.

IMPURITIES.—Other roots are mixed with it.

Preparations.

1. Infusum Senegæ.—Senega root powdered, 1; boiling water, 20.

Dose, ½ to 1 fl. oz.—15 to 30 mils.

2. Tinctura Senegæ.—2 to 10 of alcohol (60 per cent.). Percolate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

ACTION.

External.—Saponin is a powerful irritant, and hence senega is an irritant to the skin.

Internal.—*Alimentary canal.*—Senega is an irritant here also, producing salivation, vomiting, and diarrhœa. Even small doses often cause indigestion.

Circulation.—If injected into the blood saponin circulates as such. It arrests the heart in diastole, and is a general protoplasmic poison. It is excreted by the skin, the bronchial mucous membrane, and the kidneys, but when given by the mouth its action is usually limited to the alimentary canal, as very little is absorbed.

Respiration.—When the powdered root is inhaled its saponin is a violent irritant to the nose, causing sneezing and coughing, together with hyperæmia and increased secretion from the respiratory mucous membrane. Saponin taken by the mouth is, to a small extent, absorbed from the stomach and excreted by the lungs, and so increases the bronchial secretion and the tendency to cough. Senega is therefore a stimulating expectorant.

Kidneys.—It is a diuretic, because the excretion of saponin through the kidneys causes irritation of them.

THERAPEUTICS.

Senega is only used as a stimulating expectorant. It is evident that it may be useful in bronchitis, when the secretion is scanty, and when the power to cough is feeble. As when absorbed it is an irritant to the bronchial mucous membrane, it must not be given in acute bronchitis, and its action as a general irritant and protoplasmic poison often renders it undesirable.

IPECACUANHA.

Ipecacuanhæ Radix.—The dried root of *Psychotria ipecacuanha.* Brazil.

CHARACTERS.—Twisted pieces not more than 15 centimetres long or 6 millimetres thick. Cortical portion thick, dark red or brown, annulated, with a short, resinous waxy fracture. Central portion whitish, woody axis. Taste acrid bitter. Odour slight, peculiar.

COMPOSITION.—The chief constituents are—(1) Emetine, $C_{15}H_{21}NO_2$, or methyl-cephaeline, an alkaloid, an amorphous white powder (turns yellow on keeping), soluble in alcohol, ether, and chloroform, not in caustic alkali. (2) Cephaeline, $C_{28}H_{38}N_2O_4$. Colourless (turns yellow on keeping), soluble in caustic alkali, less soluble in ether than emetine, but freely in alcohol and chloroform. (3) A third alkaloid, psychotrine, exists in minute quantities. (4) A mixture called ipecacuanhic or cephaelic acid. (5) A glucoside. (6) Tannin, volatile oil, starch, gum, &c.

Powdered ipecacuanha root, if used for official purposes other than the preparation of standardized preparations, must be adjusted by the addition of milk sugar till it contains 2 per cent. of alkaloids. The proportion of each varies in different specimens of the root, but as a rule there is twice as much emetine as cephaeline. Emetine hydrochloride and hydrobromide are in the market; a solution of ether of 1 grain in 8 fl. oz. of sherry is about the same strength as Vinum Ipecacuanhæ.

IMPURITIES.—Hemidesmus, which is cracked, not annulated. Almond powder, occasionally found mixed with powdered ipecacuanha root, gives odour of prussic acid when moistened.

Dose of powdered root, $\frac{1}{4}$ to 2 gr.—3 to 12 centigrms. (expectorant), **15 to 30 gr.—1 to 2 grms.** (emetic).

Preparations.

1. Extractum Ipecacuanhæ Liquidum.—Powdered ipecacuanha percolated with alcohol (90 per cent.), q.s. *Standardized to contain 2·0 per cent. of the alkaloids of the root.*

Dose, ½ to 2 m.—3 to 12 centimils.

2. Vinum Ipecacuanhæ.—Liquid extract of ipecacuanha, 1; sherry, 19. *Strength.*—0·1 per cent. of total alkaloids.

Dose, 10 to 30 m.—6 to 18 decimils (expectorant); **4 to 6 fl. dr.—16 to 24 mils** (emetic).

3. Pulvis Ipecacuanhæ Compositus.—*Synonym.*—Dover's powder. Ipecacuanha, 1; opium, 1; sulphate of potassium, 8. *Strength.*—10 per cent. of opium.

Dose, 5 to 15 gr.—3 to 10 decigrms.

4. Pilula Ipecacuanhæ cum Scillâ.—Compound ipecacuanha powder, 3; squill, 1; ammoniacum, 1; syrup of glucose, q.s. *Strength.*—5 per cent. of opium.

Dose, 4 to 8 gr.—25 to 50 centigrms.

5. Pilula Ipecacuanhæ cum Urginea.—Compound ipecacuanha powder, 3; urginea, 1; ammoniacum, 1. *Strength.*—5 per cent. of opium.

Dose, 4 to 8 gr.—25 to 50 centigrms.

6. Trochiscus Ipecacuanhæ.—0·015 grm. or ¼ gr. of ipecacuanha in each; made with a simple basis.

7. Trochiscus Morphinæ et Ipecacuanhæ.—Ipecacuanha, $\frac{1}{12}$ gr.; morphine hydrochloride, $\frac{1}{36}$ gr. in each (*see* Morphine, p. 364); made with a tolu basis.

Action.

External.—Ipecacuanha powder is a powerful irritant to the skin, producing redness, vesication, and pustulation. It has some antiseptic powers, for it can destroy anthrax bacilli, but it has no effect on the spores. This property is not due to its emetine, but to some other constituent; on the other hand, a solution of emetine will destroy the dysenteric amœba in broth culture.

Internal.—*Alimentary canal.*—Here also the irritating action of ipecacuanha is seen. It increases the flow of saliva, dilates the gastric vessels, and stimulates the secretion of gastric juice. Therefore small doses are distinctly stomachic, and aid digestion. Large doses are, however, powerfully emetic. This is chiefly due to their irritant effect upon the stomach, but in a much less degree to the fact that emetine acts directly upon the vomiting centre in the medulla, as can be proved by observing that when the alkaloid is thrown directly into the circulation vomiting follows before there is time for it to have been excreted into the stomach. Ipecacuanha is therefore both a direct and an indirect emetic. It produces a certain amount of depression, but not more than the mere act of vomiting will explain. It does not usually cause nausea. The irritant effect is continued in the intestine, and hyperæmia, excessive secretion, and purging result. In dysentery there is a peculiar tolerance of ipecacuanha. Ipecacuanha was incorrectly said to increase the amount of bile secreted, and so has been is called a direct cholagogue.

Circulation.—Large doses of emetine depress the heart powerfully, the blood tension falls, and the heart finally stops in diastole.

Respiration.—This is unaffected. Ipecacuanha powder when inhaled, or if enough ipecacuanha is taken internally for it to be excreted by the bronchial mucous membrane, causes hyperæmia of it, together with an increased secretion of bronchial mucus, and therefore, reflexly, coughing is stimulated. It is consequently an **expectorant**; and because it depresses the circulation a little it is called a depressant expectorant. Animals to which large doses of ipecacuanha or of emetine have been given show, after death, considerable hyperæmia of the bronchial mucous membrane, of the lungs, of the stomach and intes-

tines, and of the respiratory passages if ipecacuanha powder has been inhaled.

Skin.—Ipecacuanha is a mild diaphoretic.

THERAPEUTICS.

External.—Ipecacuanha is not employed for its external irritant effect. It has been used with success, as an antiseptic, in cases of anthrax. It is directed that the wound should be dressed with the powdered root, and that 5 grains (3 decigrms.) should be taken by the mouth every four hours.

Internal. — *Stomach.* — Occasionally in small doses, such as 4 or 5 minims (2 or 3 decimils) of the vinum or $\frac{1}{4}$ gr. (16 milligrms.) of the powdered root, it is employed as a stomachic, and these quantities may even stop vomiting when other drugs have failed. A usual prescription to arrest the vomiting of pregnancy is a minim of ipecacuanha wine in water every half-hour. The compound powder has been praised in cases of gastric ulcer; probably any good effect it may have is due to its stimulating power. Ipecacuanha is a very common emetic. It should not be given when it is desired, as in cases of poisoning, to empty the stomach quickly, for some time elapses before it is absorbed and influences the medulla; nor should it be given to the very feeble, for it has no action that will counteract the depression of the vomiting. But it is an excellent emetic when it is wished, by the act of vomiting, to empty the air-passages, as in bronchitis, the early stages of diphtheria, tracheitis, and laryngitis, for not only the vomiting but the effect of the ipecacuanha on the respiratory tract will be beneficial. It is chiefly employed for this purpose in children, as they cannot cough well, and often it seems to act like a charm. A good emetic powder consists of, for an adult, 20 grains (12 decigrms.) of powdered

ipecacuanha with $\frac{1}{2}$ gr. (30 milligrms.) of tartarated antimony.

The emetine contained in ipecacuanha is a specific for amœbic dysentery. But when diluted, outside the body, to the extent it must be by the intestinal contents emetine is not a powerful poison to the amœbæ, although it certainly kills them in the intestine, therefore its action there is not precisely understood. If ipecacuanha itself is used large doses must be given—30 grains (2 grms.) of the powdered root in a single dose on one day, 25 grs. the next, and so on till 145 grs. have been taken. But this treatment often makes the patient sick. Therefore all cases and carriers are best treated by giving by mouth in a cachet about 9 P.M., 3 gr. daily for 12 days of the insoluble double iodide of emetine and bismuth. Emetine is slowly liberated from this in the intestine; sometimes the irritation caused by it is a drawback, then it may be combined with a little powdered opium. If even then vomiting is caused, emetine or better still the hydrochloride, as it is more soluble, is usually given intramuscularly, $\frac{1}{2}$ gr. (30 milligrms.) night and morning and later on once a day.

The prolonged use of emetine leads to profuse diarrhœa, emaciation and, in animals, death.

Half a grain to a grain is often combined in a pill with other so-called cholagogues to relieve cases of hepatic dyspepsia, and sometimes with excellent results.

Respiration.—Ipecacuanha is a very common expectorant. Lozenges may be sucked, or the acetum or vinum may be given internally. It is suitable in cases of bronchitis or phthisis in which the secretion is scanty, and therefore there is much purposeless cough; and also when the disease is long-standing, for then the stimulation of the chronically inflamed mucous membrane will aid the cure of it. Its power of exciting the act of coughing adds to its usefulness.

Skin.—Dover's powder is very commonly used as a diaphoretic in mild feverish attacks.

LOBELIA.

Lobelia.—The dried flowering herb of *Lobelia inflata*. North America.

CHARACTERS.—The stems are angular, channelled and with narrow wings. Purple, scarred, hairy. Capsules inflated, two-celled, containing minute oblong reticulated brown seeds. Odour irritating. Taste first mild, then burning and acrid when chewed.

COMPOSITION.—The chief constituents are—(1) *Lobeline*, a liquid volatile oily alkaloid, 30 per cent. Taste pungent. Odour like tobacco. It is combined with (2) lobelic acid, and forms crystallizable salts. (3) Inflatine.

INCOMPATIBLES.—Caustic alkalies, as they decompose lobeline.

Preparation.

Tinctura Lobeliæ Ætherea.—Lobelia, 1; spirit of ether, 5. Percolate.

Dose, 5 to 15 m.—3 to 10 decimils.

ACTION.

External.—Lobelia has no effect on the skin, but it is stated that poisonous symptoms may occur from absorption of it through the epidermis.

Internal.—*Gastro-intestinal tract.*—Moderate or large doses are powerfully irritant, and cause violent vomiting and purging. These results are accompanied by very intense prostration, as shown by the feeble pulse, cold sweats, pale skin, and great muscular relaxation.

Circulation.—The heart is at first stimulated, but soon depressed, and it finally becomes rapid, irregular, and feeble. The blood-pressure falls. These effects on the gastro-intestinal tract and circulation are due, like those of nicotine and coniine, to paralysis of nerve ganglia.

Respiration.—Small doses slow respiration; large

doses strongly depress the respiratory centre, and death takes place from respiratory failure. The muscular coat of the bronchi is relaxed.

Nervous system.—Toxic doses are required to affect the higher cerebral centres, and then coma and convulsions are produced, but it is not clear how far these results are due to asphyxia. Experiments seem to show that the motor centres of the cord are depressed. Muscles and nerves are unaffected.

Lobeline is probably excreted by the kidneys and skin.

THERAPEUTICS.

Lobelia has been recommended as a purgative and as an emetic, but it should not be used for these purposes, because of its great liability to produce collapse. It is employed in asthma to relax the muscular coat of the bronchial tubes, but it is of very little use unless large doses are given and they are not to be recommended because of the severe depression they cause. It may also be prescribed for bronchitis accompanied by spasmodic dyspnœa.

VIRGINIAN PRUNE BARK.

Pruni Virginianæ Cortex.—The bark of *Prunus serotina*, the wild cherry, collected in the autumn.

CHARACTERS.—Curved pieces or fragments about 3 millimetres thick. Frequently smooth and reddish, with transversely elongated lenticels and short granular fracture. Taste, astringent and bitter. Odour after maceration with water like bitter almonds.

COMPOSITION.—It contains (1) Amygdalin, which yields with water glucose, hydrocyanic acid, and essential oil of bitter almonds (*q.v.*). (2) Emulsin.

Preparations.

1. **Syrupus Pruni Virginianæ.**—Virginian prune bark, 150; refined sugar, 750; glycerin, 651; water to 1000. Percolate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

2. Tinctura Pruni Virginianæ.—Virginian prune bark, 200; alcohol (90 per cent.), 565; distilled water, 365; glycerin, 100. Macerate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

Action and Therapeutics.

When this drug is treated with water, hydrocyanic acid is formed, and that is probably the reason why it is efficacious in relieving cough, especially a hacking cough, by which nothing is expectorated, for prussic acid diminishes reflex excitability. Virginian prune is a very favourite remedy, and the syrup is a very useful flavouring agent for cough mixtures.

GROUP IV.

Vegetable Drugs having Antiperiodic, Antipyretic, and Antiseptic Properties.

Cinchona Bark, Quinine, Salicin, Salicylates, Oil of Gaultheria, Alstonia, Berberis.

CINCHONA BARK.

Cinchonæ Rubræ Cortex.—Red Cinchona Bark. The dried bark of the stem and branches of cultivated plants of *Cinchona succirubra.*

Characters.—Quills or incurved pieces, five to thirty centimetres long, two and a half to six millimetres thick, coated with periderm. Outer surface rough from longitudinal furrows, ridges, transverse cracks, annular fissures, and warts, brownish or reddish brown. Inner surface brick-red or deep reddish brown, irregularly and coarsely striated. Fracture nearly close in the smaller quills, finely fibrous in the larger. Powder brown or reddish brown. No odour. Taste bitter and astringent.

Composition.—The chief constituents of cinchona bark are four alkaloids, two acids, a glucoside, tannin, a colouring matter, and a volatile oil. (There are thirty-one cinchona alkaloids, but only four are important.)

(1) *Quinine.*—An alkaloid. $C_{20}H_{24}N_2O_2$. Exists as the hydrate. White acicular crystals, inodorous, very bitter. Gives a green colour with chlorine water and ammonia; turns the plane of polarization to the left; solutions of its salts are fluorescent. Soluble in ether and in ammonia. Forms salts with acids. (*See* Sulphate and Hydrochloride, pp. 476 to 478.)

(2) *Quinidine.*—An alkaloid. $C_{20}H_{24}N_2O_2$. Isomeric with quinine, differing from it only in crystallizing in prisms, turning the plane of polarization to the right, and not being soluble in ammonia except in excess.

(3) *Cinchonine.*—An alkaloid. $C_{19}H_{22}N_2O$. Colourless prisms, inodorous, bitter. No green colour with chlorine water and ammonia. Turns the plane of polarization to the right. Not fluorescent. Almost insoluble in ether and in ammonia.

(4) *Cinchonidine.*—An alkaloid. $C_{19}H_{22}N_2O$. Isomeric with cinchonine, differing from it in turning the plane of polarization to the left, being sparingly soluble in ether, and being slightly fluorescent.

Good red bark should yield 5 to 6 per cent. alkaloids, not less than half being quinine and cinchonidine. Of non-official cinchona barks, good yellow bark should yield 2·5 to 3·5 per cent. of quinine, and pale bark, very little quinine, but 0·7 to 1·4 total alkaloids, chiefly cinchonine and quinidine.

(5) *Chinic or quinic acid.*—$C_7H_{12}O_6$. Large colourless prisms. It and its salts are soluble in water, and thus quinine may be given subcutaneously as quinate of quinine. This acid is found in the coffee bean and other plants. It is allied to benzoic acid, and appears in the urine as hippuric acid.

(6) *Chinovic acid.*—A white amorphous substance related to chinovin.

(7) *Chinovin.*—A glucoside, which easily decomposes into glucose and chinovic acid.

(8) *Cincho-tannic acid.*—1 to 3 per cent. It is the astringent principle of cinchona bark. It differs from tannic acid in striking green with per-salts of iron. It is easily oxidized to cinchona red.

(9) *Cinchona red.*—The colouring matter of the bark. It is almost insoluble in water.

(10) *A volatile oil.*—This exists in minute quantities. Cinchona bark owes its smell to it.

Remijia bark (from which quinine may be prepared) yields in addition homoquinine, which yields quinine and another alkaloid, cupreine.

Impurities.—Inferior barks, known by their not yielding the full strength of quinine and cinchonidine.

INCOMPATIBLES.—Ammonia, lime water, metallic salts, and gelatin.

The Pharmacopœia directs that the official bark, when used to make the preparations of it, should contain between **5 and 6 per cent.** of total alkaloids, of which not less than half consists of quinine and cinchonidine.

Preparations.

1. **Extractum Cinchonæ Liquidum.**—Red cinchona bark powdered, 1000; hydrochloric acid, 31; glycerin, 125; alcohol (90 per cent.), q.s.; distilled water, q.s. *Standardized to contain* 5 *per cent. of total alkaloids, or* 5 *gr. in* 110 ♏.
   Dose, 5 to 15 m.—3 to 10 decimils.

2. **Infusum Cinchonæ Acidum.**—Red cinchona bark, 1; aromatic sulphuric acid, $\frac{1}{4}$; boiling water, 20.
   This is a solution of the sulphates of the alkaloids.
   Dose, $\frac{1}{2}$ to 1 fl. oz.—15 to 30 mils.

3. **Tinctura Cinchonæ.**—Red cinchona bark, and alcohol (70 per cent.). Percolate. *Standardized to contain* 1 *per cent. of total alkaloids*, 1 *grm. in* 100 *millilitres, or* 1 *gr. in* 110 ♏.
   Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

4. **Tinctura Cinchonæ Composita.**—Tincture of cinchona, 500; dried bitter orange peel, 50; serpentary, 25; cochineal, 3; alcohol (70 per cent.), to produce 1000. Mix. *Standardized to contain* 0·5 *per cent. of total alkaloids*, 0·5 *grm. in* 100 *millilitres, or* $\frac{1}{2}$ *gr. in* 110 ♏.
   Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

It will be noticed that all preparations of cinchona bark are directed by the Pharmacopœia to be made from red cinchona bark, but quinine salts may be made from various kinds.

Quininæ Sulphas.—Quinine Sulphate. $([C_{20}H_{24}N_2O_2]_2H_2SO_4)_2,7\frac{1}{2}H_2O$.

SOURCE.—The sulphate of an alkaloid, quinine, prepared from the powder of the various species of cinchona bark.

CHARACTERS.—Filiform, silky, very light, snow-white crystals, with an intensely bitter taste. *Solubility.*—1 in 800 of water, and giving it a fluorescent, bluish tinge; easily in slightly acidulated water (1 ♏ of a mineral acid in 2 fl. oz. of water will dissolve 1 gr. of sulphate of quinine), but repre-

cipitated by ammonia; the precipitate is soluble in excess of ammonia and in ether; 1 in 65 of alcohol (90 per cent.).

IMPURITIES.—It should not contain more than 3 per cent. of cinchonidine, and no cinchonine, quinidine, or cupreine. Lime, chalk, magnesia, starch, and other white powders. Salicin, detected by its giving a blood-red colour with H_2SO_4.

INCOMPATIBLES.—Alkalies and their carbonates, astringent infusions.

Dose, 1 to 10 gr.—6 to 60 centigrms.

Preparations.

1. **Ferri et Quininæ Citras,** *see* Iron, p. 196.
Dose, 5 to 10 gr.—3 to 6 decigrms.

2. **Pilula Quininæ Sulphatis.**—Quinine sulphate, 82; glycerin, 12; tartaric acid, 3; tragacanth, 3.
Dose, 2 to 8 gr.—12 to 50 centigrms.

3. **Syrupus Ferri Phosphatis cum Quinina et Strychnina.**—Each fl. dr. represents $\frac{4}{5}$ gr. of quinine sulphate (*see* pp. 193, 194).
Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

4. **Tinctura Quininæ Ammoniata.**—Quinine sulphate, 2; solution of ammonia, 10; alcohol (60 per cent.), 90. Mix.
Doso, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

Quininæ Hydrochloridum.—Quinine Hydrochloride. $C_{20}H_{24}N_2O_2HCl,2H_2O$.

SOURCE.—The hydrochloride is obtained from quinine.

CHARACTERS.—Crystals resembling those of the sulphate, but larger. *Solubility.*—1 in 35 of cold water, 1 in 3 of alcohol (90 per cent.). Very soluble in boiling water or boiling alcohol. Its solution gives a green colour with chlorine water and ammonia.

Dose, 1 to 10 gr.—6 to 60 centigrms.

Preparations.

1. **Tinctura Quininæ.**—Quinine hydrochloride, 2; tincture of orange, 100. Dissolve.
Dose $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

2. **Vinum Quininæ.**—Quinine hydrochloride, 2; orange wine, 875.
Dose, $\frac{1}{2}$ to 1 fl. oz.—16 to 30 mils.

Quininæ Hydrochloridum Acidum.—Acid Quinine Hydrochloride. $C_{20}H_{24}N_2O_2,2HCl$.

CHARACTERS.—The acid hydrochloride is a white crystalline powder, soluble in less than its own weight of water and yielding an acid liquid.

Dose, 1 to 10 gr.—6 to 60 centigrms.

ACTIONS OF CINCHONA BARK AND ITS ALKALOIDS.

The action of cinchona bark is due almost entirely to the alkaloids in it. The following description will be that of the action of quinine sulphate, which is often called quinine. Some prefer the hydrochloride as it is much more soluble, but on the addition of an acid (see p. 476) the sulphate is easily soluble. Syrup of orange to some extent hides the bitter taste of quinine and its salts.

External.—Quinine is a very powerful antiseptic. A solution of 1 in 500 destroys many micro-organisms, and a solution of 1 in 250 prevents fermentation and putrefaction. It is very fatal to most low forms of animal and vegetable life, for it is a general protoplasmic poison, retarding oxidation and metabolism. No effect is produced upon the sound skin by quinine, but it is irritant to a raw surface.

Internal.—*Alimentary canal.*—Quinine acts like any other bitter, such as calumba. The bitter taste is very marked; in the mouth the gustatory nerves, and in the stomach the gastric nerves are stimulated. This leads reflexly to an increase of the salivary and gastric secretions, and to greater vascularity and peristalsis of the stomach, the appetite is sharpened, and digestion is aided. Quinine is, therefore, a stomachic. These effects, of course, bring about a better absorption of food; and hence, if digestion was previously feeble, the patient feels stronger after a course of quinine. In the stomach any salt of

quinine is converted into a chloride, some of which is absorbed there. In the intestines it is probably precipitated by the alkaline secretions; but as quinine is soluble in alkaline waters if aerated, perhaps some of it remains in solution. It is often excreted unchanged in the fæces.

Blood.—Quinine, as a chloride, is readily absorbed into the blood; and although this is alkaline, it is not precipitated, being probably held in solution as carbonate of quinine by the gases of the blood. It is not known to undergo any alteration there, but it produces some remarkable changes in blood.

(*a*) *White corpuscles.*—If the movements of the white corpuscles are being watched in a drop of blood on the warm stage of the microscope, and some quinine is added, they at once cease. Again, if the mesentery of a living frog be put under the microscope, and slightly irritated so as to set up inflammation, emigration of the white corpuscles through the capillary walls, or diapedesis, as it is called, will be observed; if now some quinine be injected into the circulation this ceases, but those white corpuscles that have already passed out wander further from their capillary. If the quinine be applied locally to the mesentery, directly the white corpuscles have passed through their capillary their movement is stopped, and the motionless corpuscles collect in large numbers around the capillaries. It is clear, therefore, that quinine has the power of arresting the movements of white blood-corpuscles. In sufficient quantity it actually destroys them, for in a cat killed by quinine they are much fewer in number than in a healthy cat.

(*b*) *Red corpuscles.*—Quinine is said to cause a diminution in the size of these, but this is most likely not strictly correct. In fever, if the temperature is high, the red corpuscles are probably a little larger than natural. If the temperature be reduced

by any means the corpuscles regain their normal size. Quinine will reduce the temperature, but it probably has no special action on the corpuscles.

(c) *Acidity of the blood.*—Blood outside the body gradually becomes acid. Quinine prevents this.

(d) *Oxidizing power.*—If ozonized oil of turpentine be mixed with tincture of guaiacum, nothing occurs; but if a drop of blood be added, that transfers the oxygen to the guaiacum, oxidizes it, and turns it blue. This oxidizing power of blood is prevented by the addition of quinine.

(e) *The stability of oxyhæmoglobin* is strengthened by quinine, so that the blood does not yield up its oxygen as easily as normally, consequently it cannot absorb oxygen readily. This inability of hæmoglobin to take up oxygen in the presence of quinine is parallel with its action on other varieties of protoplasm. For example, fungi absorb oxygen slowly if quinine be present, and thus fermentation may be prevented. Phosphorescent infusoria (the phosphorescence is due to rapid oxidization) lose this property in the presence of quinine. The ozonizing power of fresh vegetable juices is retarded by it. Quinine is, therefore, very constant and very powerful in interfering with oxidation.

Circulation.—Small doses of quinine probably increase the activity of the heart reflexly because they stimulate the stomach; but large doses (larger than are given to man medicinally), either applied to the excised heart or circulating through it, directly paralyse the organ; the pulse becomes slower and more feeble, and the heart is finally arrested in diastole. Whether it acts on the muscle or the ganglia is not known. Large doses lower the blood-pressure considerably; this is owing partly to the effect on the heart, but it is probable that this fall of arterial pressure is due in part also to the action of quinine on the blood-vessels. If the

spleen is enlarged as a result of malarial fever, the administration of quinine, curing the fever, leads to a decrease in the size of the spleen, but it has no direct effect on this organ, as is often asserted.

Respiration.—Although, as we have seen, quinine must, because of its retardation of oxidation, have a powerful influence on internal respiration, diminishing the activity of metabolism, it has but a moderate effect on the respiratory movements. Small doses slightly increase, large doses depress them.

Temperature.—Quinine has very little power over the healthy temperature, but that of fever is sometimes reduced; it is, therefore, an **antipyretic.** Considering its direct capability of diminishing metabolism in the tissues, it seems fair to assume that the drug **diminishes heat production,** and that it does so by acting directly on the thermogenetic tissues; but, whether it decreases heat production by also influencing the cerebral thermogenetic centres is not known.

Cerebrum.—Small doses are believed to stimulate cerebral activity. The results of experiments upon the action of quinine on the brain are so discordant as to be at present valueless. The effects of a large dose in man will be described under Cinchonism.

Spinal cord and nerves.—In frogs quinine causes a lessening of reflex excitability, which is removed by section below the medulla; but in large doses it produces a permanent diminution of reflex excitability. In these animals quinine also first excites and then paralyses the sensory nerves or their peripheral endings. The muscles are uninfluenced. These effects are not seen in man.

Uterus.—It has often been stated that quinine will lead to abortion, that it will when labour has commenced aid the expulsion of the fœtus, and that it will increase the menstrual flow if that is scanty. It appears that the first statement is certainly

incorrect, and that the second and third are correct only for some women.

Kidneys.—After a full dose of quinine it is found in the urine in half an hour, and is slowly excreted for several days, but by far the greater part is eliminated within the first forty-eight hours. The excretion of uric acid, urea, and sulphur in the urine is greatly diminished, from which we learn that quinine retards considerably the protein metabolism of the body, but it should be stated that very little alteration is observed in the absorption of oxygen and excretion of carbonic acid gas by the lungs. It is said that minute quantities of quinine are got rid of by all the secretions, as it may be detected in milk, saliva, bile, and tears, and it may be found in dropsical fluids if the patient has been taking it.

Cinchonism.—In many persons quinine produces physiological symptoms. The patient soon complains of ringing in the ears, fulness in the head, and slight deafness. With larger doses these symptoms increase, disturbances of vision and giddiness are added, he may stagger when he walks, and the headache may be very intense.

Quinine is hardly ever given as a poison, but if it should be, all these symptoms of cinchonism will be very severe; the patient may be delirious and comatose, quite deaf and blind, and if he die it will be from collapse due to cardiac and respiratory failure. Great congestion of the middle ear and labyrinth is found in animals poisoned by quinine. The mild degrees of cinchonism pass off directly the drug is discontinued. Rarely quinine causes an erythematous rash, and it may give rise to epistaxis and other hæmorrhages. Those who work among cinchona barks may have a rash on their skin from the mechanical irritation of the powder.

The other alkaloids are similar in their action to quinine.

Therapeutics.

External.—Quinine is too expensive for use as an antiseptic.

Internal.—*Gastro-intestinal tract.*—It is very largely used on account of its stomachic properties, chiefly for that variety of indigestion which is the outcome of general ill-health, want of fresh air, and anæmia, and not often when the stomach is the organ primarily at fault. The preparations of cinchona bark are very useful for this variety of dyspepsia; they contain quite enough of the alkaloids. The compound tincture has the advantage of its other stomachics. Iron is very commonly given at the same time to correct the general condition. Quinine is frequently prescribed with the tincture of perchloride of iron, there is always enough free acid in this to dissolve any preparation of quinine. Alkalies, especially sal volatile, are often given with solutions of the sulphate, but they precipitate the quinine, and therefore mucilage must be used to suspend it. The dose of the sulphate or hydrochloride as a stomachic bitter is $\frac{1}{2}$ to 2 gr. (3 to 12 centigrms.). The acid hydrochloride is often preferable, as it is more soluble.

Heart.—Quinine and still more quinidine (dose, 6 grains of sulphate of quinidine in a capsule 4 times a day) will often restore the normal rhythm in cases of auricular fibrillation.

Antipyretic effect.—Quinine was commonly used as an antipyretic, but for the rare occasions on which antipyretic drugs are required, it has now been replaced by those which are more certain, as phenacetin, acetanilide, and phenazone. It is, however, a very fairly certain antipyretic. It is best given for this purpose in a single dose of 20 to 40 grains (12 to 24 decigrms.) for an adult. Such large doses may

be prescribed either in cachets, or as a solution of the hydrochloride, or as the sulphate suspended in milk. About one or two hours elapse before the temperature begins to fall. Quinine is more efficacious in reducing a temperature just beginning to fall than a rising one. Hence if possible it should be administered an hour or two before the time at which previous experience of the particular case shows the temperature will probably attain its maximum; then the fall will be more marked and last longer than if the drug had not been given.

Specific action.—Quinine, and other cinchona alkaloids, arrest the paroxysms of malarial fever. If 30 to 45 grains (2 to 3 grms.) of quinine be taken one or two hours before the attack is due, it will not take place, or it will be very mild. The same effect follows if smaller doses, about 10 grains (6 decigrams) are taken four or five times a day between the attacks. Not only is it thus prophylactic, but the continued use of it for three or four weeks is curative. It is also preventive, even to those who have never had ague. For this purpose it is administered to those who have to enter malarious regions, and it is then found that few of them get ague. If the disease is very severe it is best to give single large doses. It is sometimes used intravenously and intramuscularly for severe resistant cases, but it must be given cautiously. Quinidine and cinchonidine are the best alkaloids for benign tertian infections, quinine for the malignant form. During the late war many cases were too severe to benefit by any of these alkaloids.

If a person has once had ague, illnesses that he subsequently suffers from are liable to assume a malarial type. This is especially the case with neuralgia, which is then peculiarly paroxysmal. It is often on the forehead, when it is called brow ague. In such illnesses the effect of quinine is frequently very well

marked, and a cure speedily takes place. Sometimes neuralgia which is not malarial is temporarily benefited. The cinchona alkaloids cure ague by acting after combination with the tissues of the patient as a poison to the protozoa, which infest the blood and are the cause of ague, and the fall of temperature is due to this action. Different forms of ague or malaria are due to different but closely allied parasites. Quinine has been given for a host of diseases, especially septicæmia, but there is no evidence that it does good to any, except those mentioned. It is stated that quinine, given to those who have malaria, causes blackwater fever; this is not so, but quinine may aggravate this disease.

The preparations of the bark contain so little quinine that they are not antipyretics nor antiperiodics.

Quinine should if possible be avoided in (1) persons suffering from acute or subacute disease of the middle ear; (2) those suffering from gastro-intestinal irritation, which it may increase; (3) those people, occasionally met with, in whom quite small doses produce very severe symptoms of cinchonism.

Both hydrobromic acid and ergotin are said to diminish the liability to cinchonism.

If it is wished to give quinine intravenously, intramuscularly or hypodermically, the best salts are the lactate (soluble 1 in 5 of water) or the official acid hydrochloride; 6 to 30 ♏ (4 to 18 decimils) of a solution of 1 gr. (6 centigrms.) of either in 6 ♏ (36 centimils) of water may be used.

Warburg's tincture is a medicine which has a very high reputation in India for malaria. It has been called Tinctura Antiperiodica. The published formula states that it is a tincture made with alcohol (57 per cent.), and containing quinine sulphate, 1 in 50; Socotrine aloes, 1 in 40; opium, 1 in 4000; rhubarb, 1 in 125; camphor, 1 in 500; with angelica seed, elecampane, saffron, fennel, gentian, zedoary, cubebs,

myrrh, and white agaric as aromatics. Dose, 1 to 4 fl. dr. (4 to 16 mils). It is often prescribed to be made without the aloes.

Quinine and Urea Hydrochloride- (Not official.) $C_{21}H_{40}N_4O_4Cl_2$. Injected subcutaneously or applied to mucous membranes, it, like cocaine, acts as a local anæsthetic, and the effects may last a week. Solutions of 0·5 to 1 per cent. have been used for rectal operations. In Crile's anoci-association method of anæsthesia large quantities of 0·25 to 0·5 per cent. solution are injected to produce complete nerve block and prevent post operative shock and pain. For painful sore throat 20 per cent. solutions may be applied locally. Suppositories (containing 5 grains) and ointments (20 per cent.) are used for piles and rectal pain.

SALICIN.

Salicinum. — $C_{13}H_{18}O_7$. A crystalline glucoside obtained from the bark of various species of *Salix* and of *Populus*.

CHARACTERS.—Colourless, shining, trimetric, tabular crystals of a bitter taste. Coloured red with sulphuric acid. *Solubility.*—1 in 28 of cold water, 1 in 1 of boiling water, 1 in 80 of alcohol (90 per cent.). Not in ether.

Dose, 5 to 20 gr.—3 to 12 decigrms.

Acidum Salicylicum.—Salicylic Acid. *Synonym.*—Orthohydroxybenzoic acid. $HC_7H_5O_3$.

SOURCE.—Made from natural salicylates, such as the oil of winter-green *Gaultheria procumbens*, which contains methylsalicylate, or the oil of sweet birch, *Betula lenta*; or it may be made by the interaction of sodium phenate and carbon dioxide.

CHARACTERS.—Distinct, prismatic, colourless crystals. Inodorous. Taste first sweetish, then acid. Light, easily diffused, irritating to the nostrils. Melt at 156°C. *Resembling salicylic acid.*—Strychnine, but the crystals of strychnine are larger, non-irritating, less soluble, solution very bitter. *Solubility.*—1 in 500 of water. Readily in alcohol, ether, hot water, solutions of ammonium citrate, ammonium acetate, sodium phosphate, or borax. The natural acid is not quite so soluble as the artificial. Aqueous solutions give a reddish violet colour with perchloride of iron.

INCOMPATIBLE.—Spirit of nitrous ether.

IMPURITIES.—Orthocresotic, metacresotic, and paracresotic acids. These exist only in artificial salicylic acid. In the best specimens they are absent.

Dose, 5 to 20 gr.—3 to 12 decigrms.

Preparation.

Unguentum Acidi Salicylici.—Salicylic acid, 1 gr.; white paraffin ointment, 49 gr.

Salicylic acid is contained in Injectio Cocainæ Hypodermica.

Sodii Salicylas.—Sodium Salicylate. $NaC_7H_5O_3$.

Source.—Obtained by acting on sodium carbonate with salicylic acid.

Characters.—Small colourless scales or pearly tabular crystals. Odour none. Taste sweetish saline. *Solubility.*—1 in 1 of water (but when this solution stands the salt containing 6 molecules of water of crystallisation may be deposited), 1 in 6 of alcohol (90 per cent.).

Incompatible.—Hydrobromic acid, for sodium bromide is formed and salicylic acid is precipitated.

Impurities.—As of salicylic acid.

Dose, 10 to 30 gr.—6 to 20 decigrms.

Methyl Salicylas.—Methyl Salicylate. It contains not less than 98 per cent. of pure methyl salicylate, $CH_3C_7H_5O_3$. *Synonyms.*—Artificial oil of wintergreen or sweet birch.

Source.—Obtained by the interaction of methyl alcohol and salicylic acid. (It is the chief constituent of oil of wintergreen and oil of sweet birch.)

Characters.—A colourless liquid, aromatic odour, warm sweetish taste, almost insoluble in water, readily in alcohol coloured violet by ferric chloride.

Dose, 5 to 15 m.—3 to 10 decimils.

Acidum Acetylsalicylicum. — Acetylsalicylic Acid, $C_9H_8O_4$. *Synonyms.*—Xaxa, Aspirin, Genaspirin.

Source.—May be obtained by the action of acetic anhydride or of acetyl chloride on salicylic acid.

Characters.—A white, crystalline powder; taste slightly acid. Sparingly soluble in water.

Dose, 5 to 15 gr.—3 to 10 decigrms.—best in cachet or tablet.

For Bismuthi Salicylas *see* p. 188, and for Salol *see* p. 493.

Action of Salicin and Salicylates.

External.—Salicin and salicylic acid are antiseptics rather more powerful than carbolic acid.

They are stimulant and mildly irritant to the skin. Locally applied they check sweating. Sodium salicylate is less antiseptic. Salicylic acid softens and removes epithelium. Methyl salicylate is rapidly absorbed when rubbed into the skin.

Internal.—*Alimentary tract.*—When inhaled or applied to the throat, salicylic acid is irritating, causing sneezing and coughing. In the stomach also it is irritant, giving rise to pain, nausea, and vomiting unless well diluted, and should therefore never be given as pill or powder. The sodium salt and salicin are much less irritating and acetylsalicylic acid still less, for, being insoluble in acids, it is not acted on till it reaches the intestines where it is dissolved by the alkaline secretions. The glucoside salicin is in the bowel converted into glucose and saligenin, $C_7H_8O_2$, and this is further decomposed into salicylic acid, salicyluric acid, $HC_9H_8NO_4$, and salicylous acid, $HC_7H_5O_2$. The bile is rendered much less viscid.

Blood.—Salicylic acid, whether taken directly or formed in the bowel from the decomposition of salicin, is rapidly absorbed in spite of its insolubility, and therefore it is probably taken up as sodium salicylate; anyhow, this is the form in which it circulates in the blood, and consequently the following description will apply whether salicin, salicylic acid, or sodium salicylate has been taken. It has been thought also to exist in the blood as an albuminate, but of this there is no evidence, nor for the theory put forward by Binz, that when the sodium salicylate meets with carbonic acid, either in the blood or in the inflamed tissues of rheumatic fever, salicylic acid is set free. Some of the salicylic acid of the sodium salt unites with glycocoll, forming salicyluric acid, which appears in the urine. Thus: $HC_7H_5O_3 + C_2H_5NO_2$ (glycocoll) $= HC_9H_8NO_4$ (salicyluric acid) $+ H_2O$. It will be noticed that this change is precisely analogous to the conversion of

benzoic into hippuric acid by its union with glycocoll. The beneficial germicidal effect of this acid is well seen in a disease of bees known as foul brood, and due to certain schizophytes, for feeding the bees on syrup containing salicylic acid cures them.

Liver.—It has been said that sodium salicylate, like sodium benzoate, increases the amount and the solids of the bile, but this is doubtful.

Heart.—Salicin and salicylic acid are often incorrectly stated to depress the force of the heart and cause a fall of blood-pressure. Careful comparison shows that salicin is not nearly so depressant as the acid—in fact, it is probable it has not this action at all unless given in toxic doses. Further, natural salicylic acid is not so depressant as some specimens of the artificial variety. For example, Charteris found that 30 grains (2 grms.) of salicin, or 10 grains (6 decigrms.) of natural salicylic acid, or 32 grains (21 decigrms.) of natural sodium salicylate had no injurious effect on a rabbit, but that much smaller doses than these of the artificial acid or its salt killed the animal. The artificial variety was found to contain orthocresotic and paracresotic acids, and the former is a powerful cardiac depressant. Thus it seems probable that the depressing effects commonly ascribed to salicylic acid are really due to the impurities occasionally present in the artificial form. Salicylic acid increases the blood pressure from stimulation of the vaso-constrictor centre.

Respiration.—Moderate doses have very little effect on respiration. Toxic doses strongly depress it.

Temperature.—In medicinal doses salicin and salicylic acid have no influence on the temperature of man, in toxic doses they slightly lower it; but they readily depress a febrile temperature, and are therefore called antipyretics. They cause a slight increase of perspiration, but this is not sufficient to explain the fall.

Salicylic acid and salicin are **antiperiodic.**

Nervous system.—We know little of the effect of salicylic acid on the individual parts of the nervous system. The clinical symptoms known as salicylism will be described presently.

Kidney.—Salicylic acid escapes chiefly through the kidneys. It to a much less extent also leaves the body by the sweat, the saliva, the bronchial secretions, and the fæces. It appears in the urine very soon after its ingestion (in from 10 to 30 minutes), but the elimination goes on slowly. It is excreted as salicyluric acid and sodium salicylate, which is split up by the phosphoric acid in the urine, yielding salicylic acid. The dark greenish colour of the urine sometimes seen is due to small quantities of either indican or pyrocatechin. Occasionally salicylic acid causes hæmaturia, due to congestion of the kidneys.

Salicylic acid increases **protein metabolism,** hence the total nitrogen and sulphur in the urine are increased. The quantity of uric acid is particularly great. It renders the **urine antiseptic,** and the salicyluric acid in that fluid will reduce Fehling's solution. The urine of patients taking it gives a **purple colour with perchloride of iron.**

Uterus.—It may cause abortion.

Salicylism.—In some persons to whom salicylic acid or its salt is given a train of symptoms is produced to which the above name has been applied. They are very like those produced by quinine. The cause of at least some of them is the impurities existing in artificial salicylic acid, but it is stated that the natural acid may very rarely give rise to them. Orthocresotic acid is certainly toxic, metacresotic acid has no action, and it is doubtful whether paracresotic acid is toxic. The commonest symptom is deafness, which is often accompanied by ringing in the ears. Headache is also very frequent. The administration of the drug is

usually stopped when these symptoms show themselves, but if it is continued the patient becomes violently delirious, there is nausea and vomiting, the face is flushed, and the other symptoms increase in severity. The pulse falls in both frequency and force, it becomes irregular, epistaxis is common, and hæmorrhages from other parts of the body have been recorded, such as hæmaturia and retinal hæmorrhage. Albuminuria without hæmaturia has been observed. One of the rarest symptoms is erythema or urticaria. Very large doses may cause the breathing to become weaker, and death may take place either from cessation of the heart or of the respiratory movements.

Therapeutics.

External.—The ointment may be used when an antiseptic stimulating ointment is required. A collodion composed of salicylic acid, a drachm, collodium flexile, an ounce; a glycerin containing 10 per cent. of salicylic acid; and a plaster, also 10 per cent., are good preparations. Strong applications of salicylic acid are very useful for removing excess of epidermis, warts, or corns. Salicylic acid 11 parts, Extract of Cannabis Indica 2 parts, Collodion flexile 87 parts, form an excellent remedy (commonly known as green solution) for soft corns. Powdered salicylic acid mixed with starch or chalk may be employed to check profuse perspiration of the feet and axillæ. The German Pharmacopœia has for this purpose a Pulvis Salicylicus cum Talco (salicylic acid, 3; wheaten starch, 10; talc, in powder, 87). The sweats of phthisis may be treated in the same way. A little salicylic acid is often added to Thompson's fluid (pp. 280-281). A preparation called "Antiphlogistine" is much used externally to relieve pain. It is said to be composed of glycerin, salicylic acid, boric acid,

ferrous carbonate, peppermint, gaultheria, eucalyptus, and iodine, combined with an earthy base.

Methyl salicylate is very useful when rubbed in for chronic rheumatism or lumbago; an ointment of 1 in 2 to 4 of lanolin may be used, and a liniment (Linimentum Methylis Salicylatis B. P. C.) containing methol, 5; oil of eucalyptus, 10; essential oil of camphor, 25; methyl salicylate to 100, is of value when painted on the painful parts and covered with flannel or gutta percha.

Internal.—Salicylic acid is a specific for rheumatic fever; it lowers the temperature, lessens the swelling, leads to a rapid cessation of pain, and diminishes the liability to pericarditis and other complications. It must be given well diluted to prevent dyspepsia. The sodium salt is often preferred as being the most soluble, but in order to diminish the risk of salicylism it should be prepared either from pure artificial or from natural salicylic acid. If the attack is severe, 20 grains every two or three hours should be given for the first twelve or twenty-four hours; then, if the patient is doing well, the frequency of the dose may be gradually diminished, but it should be continued thrice daily for ten days after the temperature is normal and the pain has ceased. The micro-organism which is believed to be the cause of rheumatic fever forms formic acid, which is excreted by the sweat and urine. The formation of this acid is controlled by the administration of salicylic acid. Salicin is not so powerful as sodium salicylate, but it is said to be less depressant than the synthetic acid. Some believe that the rheumatic varieties of endocarditis, myocarditis, and chorea are benefited by salicylates.

These preparations are of no use for gout or severe osteo-arthritis, but occasionally the pains of chronic rheumatism, sciatica, migraine, and painful menstruation are somewhat relieved, acetyl salicylic

acid is largely used for these disorders. With some persons it acts as an hypnotic.

Salicylic acid or salicin may produce a fall of temperature in any fever, but, as we have more certain antipyretics, they are not used except for rheumatic fever.

Some writers have found salicylic acid useful in diabetes.

It has been given to render the urine acid in cases of alkaline urine and cystitis, but there are better remedies for this purpose.

It has also been given in cases of gallstone with the object of rendering the bile less viscid.

OIL OF GAULTHERIA.

Oleum Gaultheriæ. *Synonym.*—Oil of winter-green. The oil distilled from the leaves of *Gaultheria procumbens*, or from the bark of *Betula lenta*. It contains not less than 99 per cent. of esters calculated as methyl salicylate $CH_3C_7H_5O_3$.

Characters.—Colourless or slightly yellowish. Odour characteristic.

Dose, 5 to 15 m.—3 to 10 decimils.

Action and Therapeutics.

The action and uses of this oil are exactly the same as those of other salicylates. It is used chiefly in the North American Colonies.

Mesotan.—(Not official.) Methoxymethyl ester of salicylic acid. A pale yellow fluid. Mixes with oil, and when painted on the skin is quickly absorbed. It has been applied for chronic rheumatism, but without much benefit. A usual formula is equal parts of mesotan and olive oil lightly rubbed in or painted on with a camel's-hair brush. It is not to be recommended as it may cause a severe dermatitis.

SALOL.

Salol.—Phenyl salicylate. $C_{13}H_{10}O_3$.

Source.—Prepared by the interaction of salicylic acid and phenol.

Characters and Tests.—Small colourless crystals of a faint aromatic odour and almost tasteless. *Solubility.*—Not

in water; 1 in 15 in alcohol (90 per cent.), 3 in 1 in ether or chloroform. Contains 60 parts of salicylic and 40 of carbolic acids.

Dose, 5 to 20 gr.—3 to 12 decigrms.—in cachets or suspended. The large quantity of carbolic acid in salol renders caution necessary when large doses are given.

Action and Therapeutics.

External.—It is an antiseptic, and when mixed with talc (1 in 5) may be used as a dusting powder.

Internal.—In the intestine salol splits up into carbolic and salicylic acids, and the former may render the urine dark. A good mouth wash consists of salol 2·5, saccharin 0·004, peppermint oil 0·5, alcohol (80 per cent.) 97, with clove and caraway oil added.

In rheumatic fever it is efficacious on account of the salicylic acid it contains, but it has no advantage over salicin or salicylic acid, and the carboluria may be troublesome. It is used as an intestinal disinfectant. These have been discussed when describing naphthol (p. 347) and on p. 100. It disinfects the urinary tract. The following is a good way of prescribing it:—Salol, gr. 10 (6 decigrms.); almond oil, ♏ 20 (12 decimils); powdered acacia, gr. 10 (6 decigrms.); syrup, ♏ 20 (12 decimils); water, 4 fl. dr. (15 mils). The emulsion should be made in a warm mortar with water at 65°C.

ALSTONIA.

Alstonia.—The dried bark of *Alstonia scholaris* and *Alstonia constricta.*

Characters.—The bark of *A. scholaris* is in fragments 3 to 12 mm. thick; spongy texture; externally rough, and brownish grey; internally bright buff; taste bitter. That of *A. constricta* is in curved pieces or quills 60 mm. wide, 12 mm. thick; rusty brown externally, cinnamon colour internally.

Used chiefly in India, Australasian Colonies, and Eastern Colonies.

Preparations.

1. Infusum Alstoniæ.—Alstonia, 1; boiling water, 20.

Dose, $\frac{1}{2}$ to 1 fl. oz.—15 to 30 mils.

2. Tinctura Alstoniæ.—Alstonia, 125; alcohol (60 per cent.), 1000. Macerate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTICS.

A. scholaris grows in the Philippines, where it is called 'Dita bark.' It contains many alkaloids, the best known being ditaine, which paralyses motor centres, motor nerves, and vagi of frogs, and in mammals paralyses motor nerve endings.

A. constricta grows in Australia, and is there called Australian fever bark. Its most active body is alstonine. Both varieties are used in dysentery, chronic diarrhœa, and intermittent fever, during the disease as well as during convalescence. Both have been employed as anthelmintics.

BERBERIS.

Berberis.—The dried stem of *Berberis aristata*.

CHARACTERS.—Undulating pieces, two-and-a-half to five centimetres in diameter, covered with orange brown periderm. The wood is bright yellow. Faint odour. Bitter taste.

Preparation.

Tinctura Berberidis.—1 in 10 of alcohol (60 per cent.). Percolate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTICS.

The drug is largely used in the various forms of remittent fever, but it is far inferior to quinine. It is also given as a diaphoretic and diuretic. An extract of it, known as rasot, is used as a paint in chronic ophthalmia. The chief alkaloid is berberine.

GROUP V.

Vegetable Purgatives.

CLASS I.—Laxatives.
Tamarinds, Cassia, Castor Oil.

CLASS II.—Simple purgatives. (All are Anthracene purgatives.)
Rhubarb, Purgatin, Purgen, Senna, Cascara Sagrada, Aloes.

CLASS III.—Drastic purgatives.
Scammony, Ipomœa Root, Jalap, Kalanda, Turpeth, Croton Oil, Colocynth.

CLASS IV.—Cholagogues.
Podophyllum, Euonymus Bark, Iridin.

CLASS I.—Laxatives.

TAMARINDS.

Tamarindus.—The fruit of *Tamarindus indica* freed from the brittle outer part of the pericarp and preserved with sugar. West Indies.

CHARACTERS.—A reddish-brown, moist, sugary mass, enclosing strong-branched fibres, and brown, shining seeds, each enclosed in a tough membranous coat. Taste agreeable, refreshing, subacid.

IMPURITY.—Copper.

COMPOSITION.—The chief constituents are—(1) Tartaric acid and potassium tartrate. (2) Citric, acetic, and other acids. (3) Sugar.

Tamarind is contained in Confectio Sennæ, 9 in 75.

ACTION AND THERAPEUTICS.

Tamarind is pleasant and acid to the taste, and a mild laxative. It may be made into tamarind whey (1 part of tamarinds to 30 of milk) and given as an acid, cooling, slightly purgative drink in fevers. It is a good purgative for children, and may be spread on bread and butter.

CASSIA PODS.

Cassiæ Fructus.—The ripe fruits of *Cassia Fistula*, the purging cassia.

CHARACTERS.—Long, narrow, cylindrical, shortly stalked fruits, 35 to 50 centimetres long, 15 to 25 millimetres in diameter. Pericarp nearly smooth, dark brown or nearly black; thin and hard. Internally divided by thin transverse dissepiments into numerous compartments, each of which contains a smooth, oval, reddish brown seed surrounded by a nearly black, sweet pulp.

CASSIA PULP.

Cassiæ Pulpa.—The pulp obtained from the crushed pods of *Cassia Fistula* by percolation with distilled water and evaporation to the consistence of a soft extract.

COMPOSITION.—The chief constituents are—(1) A purgative principle closely allied to cathartic acid. (*See* Senna, p. 503.) (2) Sugar 60 per cent.

Cassia pulp is contained in Confectio Sennæ, about 9 in 75.

ACTION AND THERAPEUTICS.

It is a laxative, only given in confection of senna.

CASTOR OIL.

Oleum Ricini.—The fixed oil expressed from the seeds of *Ricinus communis*. India.

CHARACTERS.—Viscid, colourless or pale yellow. Odour faint, characteristic. Taste slight but unpleasant. Sp. gr. 0·958 to 0·970. *Solubility.*—1 in 1 of absolute alcohol, 1 in 3·5 of alcohol (90 per cent.). These are the characters of the pure oil expressed in the cold. Much that is sold is expressed by the aid of heat. This is dark in colour and very nasty.

COMPOSITION.—The chief constituents are—(1) *Ricinoleate of glyceryl*, $C_3H_5(C_{18}H_{33}O_3)_3$. This constitutes the chief bulk. (2) Other fixed oils, as palmitin, stearin, &c. (3) Possibly an alkaloid, ricinine, not purgative. (4) According to some authorities an active principle which has not yet been isolated.

Dose, 1 to 8 fl. dr.—4 to 30 mils.

Preparation.

Mistura Olei Ricini.—Castor oil, 375; orange-flower water of commerce, 150; gum acacia, 100; cinnamon water to 1000. (Contains nearly 3 fl. dr. of castor oil in 1 fl. oz.)

Dose, 1 to 2 fl. oz.—30 to 60 mils.

Castor oil is contained in Collodium Flexile, Linimentum Sinapis, and Pilula Hydrargyri Subchloridi Composita. (Castor-oil seeds are not official, but it is important to recognise them. They are $\frac{2}{3}$ in. long and $\frac{1}{3}$ in. wide, ovoid, flattened. The seed is prolonged into a sharp beak. Epidermis shiny grey, marked by brownish bands and spots. Kernel white. They contain 50 per cent. of the oil, and an acrid substance which makes them poisonous. Three castor-oil seeds have been known to kill an adult man.)

Action.

External.—Castor oil is, like olive oil, protective and sedative, and may be used to drop into the eye when the conjunctiva is inflamed, and as a solvent for homatropine, but this solution is occasionally a little irritating.

Internal.—*Gastro-intestinal tract.*—The nastiness of castor oil is mostly due to the smell, and is not noticed much if the nose is held when the oil is drunk. Medicinal doses produce no effect on the stomach. Operating chiefly on the small intestine the oil is an excellent **simple laxative** or mild purgative, acting in about five hours, and causing no griping nor subsequent constipation. The motion is soft but not liquid. Castor oil will purge even when rubbed into the skin. The ricinoleate of glyceryl in the oil is decomposed in the duodenum, and the ricinoleic acid purges. Castor oil will purge when given *per rectum.*

Mammary glands.—Applied locally to the breasts it is said to be **galactagogue.**

THERAPEUTICS.

Castor oil is perhaps the best simple purgative we have, and is very useful in cases in which there is slight temporary constipation. Being mild in its action it is very suitable for getting rid of undigested food that is causing diarrhœa, and a dose of castor oil with a minute quantity of laudanum in it is a favourite remedy for certain forms of diarrhœa. It is also especially convenient in pregnancy, after delivery, and when in any abdominal disease, as typhoid fever, peritonitis, or when, after abdominal operations, the irritation caused by the fæces makes it absolutely necessary to get the bowels open. Also it is very useful for children, or for very old or infirm persons, or for those suffering from piles or fissures. It is a good purgative to give before and after the use of anthelmintics, and taken daily for weeks or even months is valuable for any form of chronic colitis.

Its nastiness is the only objection to it. As already mentioned, this can largely be overcome by holding the nose, and there are many forms of castor oil in the market so prepared as to be almost colourless and odourless. It may be taken in capsules, but they are bulky. The pharmacopœial mixture is not to be recommended. Lemon juice or coffee conceals the taste to some extent, or the oil may be added to a teaspoonful of peppermint water, and then a little brandy added till the oil neither sinks nor swims, or a little salt may be dissolved in half a teacupful of warm water, the oil put on this with a sprinkle of pepper on it. If the inside and rim of the glass are moistened with the vehicle, the oil, which should, if possible, be between two layers of the vehicle, is hardly tasted.

As an enema (castor oil 1 fl. oz. (30 mils), warm olive oil 5 fl. oz. (150 mils), mix thoroughly) it is often very useful when a mild injection is required.

Breasts.—The leaves of the castor-oil plant applied to the breasts will sometimes induce the secretion of milk. A fluid extract of them may also be taken three or four times a day.

Castor-oil seeds are many times more purgative than the oil, because they contain a toxalbumin, ricin, which, when injected into the blood, is one of the most powerful vegetable poisons known. It is much less active when swallowed, as it is largely destroyed by digestive ferments. After death the mucous membrane of the intestine is violently inflamed, there are ecchymoses all over the body, and blood in the serous cavities. Ehrlich, by gradually increasing the dose of ricin, was able to render animals immune to it, and this was shown to be due to the formation in their body of antiricin, which neuralized the action of the ricin. This discovery was the basis of our knowledge of serum therapeutics.

Class II.—Simple Purgatives.

(All are *Anthracene* purgatives.)

RHUBARB.

Rhei Rhizoma.—Rhubarb Root. This was called Rhei Radix B. P. 1898. The rhizome partly deprived of its bark and dried, of *Rheum officinale* and other species of *Rheum.* China and Tibet.

Characters.—Cylindrical, conical, plano-convex, or irregular pieces. Outer surface sometimes covered with a bright yellowish powder; rounded or angular, smooth or a little wrinkled, showing beneath the powder reddish-brown lines mixed with a yellowish-brown substance, and usually small star-shaped spots. The pieces are often bored with a hole, which may contain the remains of the cord used to suspend them to dry. Internally hard, compact, fracture uneven, and with a marbled appearance. Odour peculiar, aromatic. Taste feebly astringent, bitter; there is gritty feeling between the teeth when chewed.

Composition.—The chief constituents are—(1) *Chrysarobin* (*synonyms*, rhein, chrysophan, *see* Chrysarobinum). (2) *Chrysophanic acid* or *dioxymethylanthraquinone.* It is not known whether, when alive, rhubarb contains any chrysophanic acid, for when kept the chrysarobin quickly oxidizes to chrysophanic acid. The chrysarobin gives the yellow colour. (3) *Emodin* or *trioxymethylanthraquinone.* (4) *Rheo-*

tannic acid, to which the astringency of rhubarb is due (5) *Oxalate of lime*, 35 per cent., to which the grittiness is due. (6) Other bodies, about which little or nothing is known.

IMPURITIES.—English rhubarb; different taste, smell, and excess of starch. Turmeric, which is turned brown by boric acid.

Dose, 3 to 10 gr.—2 to 6 decigrms. (repeated administration), **15 to 30 gr.—1 to 2 grms.** (single administration).

Preparations.

1. **Extractum Rhei.**—Alcoholic.
Dose, 2 to 8 gr.—12 to 50 centigrms.

2. **Infusum Rhei.**—1 in 20 of boiling water.
Dose, ½ to 1 fl. oz.—15 to 30 mils.

3. **Pilula Rhei Composita.**—Rhubarb, 25; aloes, 20; myrrh, 14; hard soap, 14; oil of peppermint, 2; syrup of glucose, 25.
Dose, 4 to 8 gr.—25 to 50 centigrms.

4. **Pulvis Rhei Compositus.** *Synonym.*—Gregory's powder. Rhubarb, 22; light magnesia, 66; ginger, 12.
Dose, 10 to 60 gr.—6 to 40 decigrms.

5. **Syrupus Rhei.** — Rhubarb, 70; oil of coriander, 0·5; sugar, 840; alcohol (90 per cent.), 280; water, to 1000.
Dose, ½ to 2 fl. dr.—2 to 8 mils.

6. **Tinctura Rhei Composita.**—Rhubarb, 100; cardamoms, 12·5; coriander, 12·5; glycerin, 100; alcohol (45 per cent.), to produce 1000. Percolate.
Dose, ½ to 1 fl. dr.—2 to 4 mils (repeated administration); **2 to 4 fl. dr.—8 to 16 mils** (single administration).

ACTION.

External.—Probably rhubarb would have, to a mild degree, the same action as Goa powder, but it is never applied externally.

Internal.—*Alimentary canal.*—In the mouth, rhubarb increases the flow of saliva; and in the stomach, in small doses, it, like any other bitter substance, stimulates the flow of gastric juice, and

the vascularity and peristaltic movements of the stomach. It is, therefore, a **stomachic**, and will aid digestion. In large doses it causes **purgation**, producing in from four to eight hours a liquid motion, coloured yellow by the chrysophan. Purgation is due to the chrysophanic acid and emodin, both, like anthracene, anthraquinone derivatives, and it has been already pointed out that many vegetable purgatives owe their properties to derivatives of this body (*see* p. 95). The resinous constituents of rhubarb are said to increase the flow of bile, but certainly its cholagogue action is not sufficiently powerful to explain its purgative properties. It is commonly stated to exaggerate very actively intestinal peristalsis, but there is no adequate proof of this. It is liable to gripe. The purgation is followed by constipation; this is ascribed to the rheo-tannic acid: if so, it is probably absorbed and subsequently re-excreted into the intestine, otherwise it would all be swept away in the purging.

Kidneys.—The colouring matter is excreted in the urine, and stains it yellow when acid, red when alkaline. The urinary flow is slightly increased.

Therapeutics.

Rhubarb is commonly given to children as a stomachic purgative in indigestion, especially when caused by errors of diet, for it clears away any undigested food, and its stomachic and after-astringent effects are valuable. In the same way it is useful in diarrhœa due to irritation caused by undigested food; here the after-astringency is especially serviceable. A powder of powdered rhubarb and sodium bicarbonate (which hides the taste) equal parts, with some powdered gentian, or a similar fluid medicine, forms an excellent stomachic for young children. Rhubarb should never be given alone, because of the griping it causes.

Purgatin.—(Not official.)

This is the usual name for Anthrapurpurin diacetate.

Dose, 15 to 30 gr.—1 to 2 grms.

Purgatin is of great interest, as it is a derivative of anthraquinone, and it was the first made synthetic purgative. It may cause colic and irritate the kidneys, but a great practical objection to its use is that it colours the urine a bright red. (For purgen, *see* p. 340.)

SENNA.

Sennæ Folia.—Senna Leaves. The dried leaflets of *Cassia acutifolia* and of *Cassia angustifolia*, known in commerce as Alexandrian Senna and Tinnevelly Senna.

Characters.—Pale greyish or yellowish green, thin, brittle, 2 to 4 cm. long. Lanceolate or oval-lanceolate, acute, entire, unequal at base. Finely pubescent. Veined on the lower surface. Alexandrian is smaller than Tinnevelly.

Composition.—The chief constituents are—(1) *Cathartic acid*, an amorphous sulphurated glucoside. $C_{180}H_{192}N_{82}SO_{2}$. It exists as salts of earthy bases, such as calcium and magnesium. These salts are soluble in water. Cathartic acid is capable of decomposition into glucose and cathartogenic acid. It is the chief purgative principle in senna and other purgatives. (2) Other glucosides, sennacrol and sennapicrin, which do not in most preparations contribute to their action, as they are insoluble in water. (3) Chrysophanic acid, or dioxymethylanthraquinone, in small amounts (*see* Rhubarb and Chrysarobinum). (4) Emodin, or trioxymethylanthraquinone. (5) A sugar, catharto-mannite. *Resembling senna.*—Leaves of *Solenostemma Argel*, Uva Ursi, and Barosma, all equal at the base.

Impurities.—Any of the above.

Preparations.

1. **Confectio Sennæ.**—Senna, 100; coriander fruit, 40; figs, 160; tamarind, 120; cassia pulp, 120; prunes, 80; extract of liquorice, 15; sugar, 400; water, to make 1000.

Dose, 60 to 120 gr.—4 to 8 grms.

2. **Infusum Sennæ.**—Senna, 100; ginger, 5; boiling water, 1000.

Dose, ½ to 1 fl. oz.—15 to 30 mils—or as a single draught, **2 fl. oz.—60 mils.**

3. **Mistura Sennæ Composita.** *Synonym.*—Black draught. Magnesium sulphate, 25; liquid extract of liquorice, 5; aromatic spirit of ammonia, 5; compound tincture of cardamoms, 10; infusion of senna, q.s. to make 100.

Dose, 1 to 2 fl. oz.—30 to 60 mils.

4. **Pulvis Glycyrrhizæ Compositus.**—Senna is the most important constituent, 16 per cent. (*see* p. 612).

Dose, 60 to 120 gr.—4 to 8 grm.

5. **Syrupus Sennæ.**—Senna, 440; oil of coriander, 0·2; sugar, 540; alcohol (90 per cent.), 2·0; alcohol (20 per cent.), 760.

Dose, ½ to 2 fl. dr.—2 to 8 mils.

6. **Tinctura Sennæ Composita.**—Senna, 200; caraway, 25; coriander, 25; glycerin, 100; alcohol (45 per cent.), to produce 1000. Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils—for repeated administration; **2 to 4 fl. dr.—8 to 16 mils**—for single administration.

Sennæ Fructus.—Senna pods. The dried ripe fruits of *Cassia acutifolia* and *Cassia angustifolia.*

Characters.—Five centimetres long, and from two to two and a half wide; broadly oblong or somewhat reniform; pale green; brownish in the centre above the seeds; very flat, rounded at the base. Pericarp papery. Seeds obovate-cuneate, flattened. Odour and taste slight. (For dose, *see* p. 505.)

Action.

External.—None.

Internal.—Senna, because of the cathartic acid in it, stimulates the muscular coat of the intestine, especially the colon, and produces some hyperæmia. Consequently the fluid contents of the small intestine are hurried through the colon, and pale yellow watery stools, containing some undigested food, are the result. Senna acts very feebly or not at all on the biliary secretion. Large doses open the bowels several times and produce **griping**, but not much hyperæmia. The emodin and chrysophanic acid in

senna make it an anthracene purge (see p. 95), but cathartic acid is the more important. Purgation by senna does not cause subsequent constipation. Some constituents of it are absorbed, and may cause the urine to be red. It will purge if injected into the veins, and will impart its purgative properties to the milk of nursing women.

Therapeutics.

Senna is a safe, useful purgative for cases of simple constipation. The leaves, because of their tendency to gripe and nauseous taste, are rarely given alone. The compound liquorice powder is to be preferred to the Mistura Sennæ ("black draught"), as this is a nasty mixture. Senna is largely used to complete the effect of duodenal purgatives, as we see in the old prescription of a blue pill at night and a black draught in the morning. Acting on the colon, it is valuable in slight cases of fæcal collection. Compound liquorice powder is much used in habitual constipation and the constipation of pregnancy. Confection of senna, coated with chocolate, forms the well-known purgative Tamar Indien, and in this form can be taken by children. It is said that the infusion contains more of the active principles than other preparations; it soon decomposes, but 1 gr. of nitre to the fl. oz. will prevent this. Some preparations of figs have senna for their active ingredient.

An infusion of senna pods is a very popular aperient, and may be taken for a long while without any harm. It is pleasant and does not gripe, and is especially useful for children. Extractum Sennæ Liquidum B. P. C. (dose, $\frac{1}{2}$ to 1 fl. dr., 2 to 4 mils) is an excellent preparation of the pods. Many patients infuse the pods themselves. For an adult six may be allowed to stand in cold water for six hours

and the infusion drunk the last thing at night. Sometimes more than six, even up to twelve, are required at first, but the dose can nearly always be reduced by gradually using fewer pods to make the infusion.

CASCARA SAGRADA.

Cascara Sagrada. *Synonyms.*—Sacred Bark, Rhamni Purshiani Cortex. The dried bark of *Rhamnus purshianus*, California buckthorn, collected at least one year before being used.

Characters.—Quills or nearly flat pieces. Smooth purplish-brown cork almost covered with lichens; inner surface brown, nearly smooth, and striated longitudinally. Fracture short externally, fibrous internally. Characteristic odour. Bitter taste.

Composition.—The chief constituents are Emodin, also contained in rhubarb and senna (*q.v.*), Cascarin, Purshianin, a glucoside, several resins, various acids, and a volatile oil.

Preparations.

1. Extractum Cascaræ Sagradæ Siccum.—Made by percolation with water and subsequent evaporation.

Dose, 2 to 8 gr.—12 to 50 centigrms.

This was Extractum Cascara Sagradæ B. P. 1898.

2. Extractum Cascaræ Sagradæ Liquidum.—Made with alcohol (90 per cent.) and water.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

3. Syrupus Cascaræ Aromaticus.—Liquid extract, 8; tincture of orange, 2; alcohol (90 per cent.), 1; cinnamon water, 3; syrup, to make 20.

Dose, $\frac{1}{2}$ to 2 fl. dr.—2 to 8 mils.

Action and Therapeutics.

Cascara sagrada is a simple laxative and aperient, not causing much griping, and resembling in its action frangula bark, which is no longer official and is now rarely used. Its emodin makes cascara an anthracene purgative. The bitter principle gives it

stomachic properties. It is very serviceable for constipation, especially if chronic. Either a single pharmacopœial dose may be taken in the evening, or 10 to 15 ♏ (6 to 10 decimils) of the liquid extract may be given three times a day before meals. One advantage of its use is that gradually increasing doses are not required. The liquid extract is very bitter; this taste may be concealed by aromatics, liquorice, or sal volatile, and it may be given in chloroform water. The aromatic syrup conceals the bitter taste very well, and a preparation known as Tinctura Laxativa (B. P. C.), dose 20 to 60 ♏ (12 to 36 decimils) (Extractum Cascaræ Sagradæ Liquidum 2, Spiritus Ammoniæ Aromaticus 2, Spiritus Chloroformi 2, Tinctura Belladonnæ 1, Tinctura Nucis Vomicæ 1), is miscible with water, and is a pleasant simple purge which is especially useful for chronic constipation, and may cure it. Cascara Jelly, dose 1 to 4 fl. dr. (4 to 16 mils), made with agar-agar jelly, makes the fæces bulky and moist.

ALOES.

Aloe.—The juice that flows from the transversely cut leaves of *Aloe chinensis*, *Aloe Perryi*, and probably other species, evaporated to dryness. Known as Curaçao aloes, Socotrine aloes, or Zanzibar aloes.

Characters.—In hard masses varying from yellowish brown to dark or chocolate brown. Fracture dull, waxy, and uniform (Curaçao and Zanzibar aloes) or uneven and porous (Socotrine aloes). Small splinters show microscopic crystals imbedded in transparent mass. Characteristic odour; taste nauseous and bitter. *Solubility.*—Almost entirely in alcohol (60 per cent.). *Resembling aloes.*—Resins of guaiacum and jalap, which are not bitter.

Composition.—The chief constituents are—(1) *Aloin* (*see* p. 508). (2) Emodin, or trioxymethylanthraquinone (see Senna). (3) A resin. (4) A trace of gallic acid. (5) A trace of a volatile oil giving the odour.

Dose, 2 to 5 gr.—12 to 30 centigrms.

Preparations.

1. **Extractum Aloes.**—Aqueous, 1 in 10.
Dose, 1 to 4 gr.—6 to 25 centigrms.
This was Extractum Aloes Barbadensis B. P. 1898.

2. **Decoctum Aloes Compositum.**—Extract of aloes, 2; myrrh, 1; potassium carbonate, 1; extract of liquorice, 8; compound tincture of cardamoms, 60; water, up to 200. Contains of the extract, 1 per cent., *i.e.* 4½ gr. in 1 fl. oz.
Dose, ½ to 2 fl. oz.—15 to 60 mils.

3. **Pilula Aloes.**—Aloes, 58; hard soap, 29; oil of caraway, 3; syrup of glucose, 10.
Dose, 4 to 8 gr.—25 to 50 centigrms.

4. **Pilula Aloes et Asafetidæ.**—Aloes, asafetida, hard soap, of each 3; syrup of glucose, 1.
Dose, 4 to 8 gr.—25 to 50 centigrms.

5. **Pilula Aloes et Ferri.**—Aloes, 2; exsiccated ferrous sulphate, 1; compound powder of cinnamon, 3½; syrup of glucose, 3½.
Dose, 4 to 8 gr.—25 to 50 centigrms.

6. **Pilula Aloes et Myrrhæ.**—Aloes, 44; myrrh, 22; syrup of glucose, 34.
Dose, 4 to 8 gr.—25 to 50 centigrms.

Aloes is contained in Pilula Colocynthidis Composita (1 in 3), and Pilula Colocynthidis et Hyoscyami (1 in 4½). Pilula Rhei Composita (1 in 6), Tinctura Benzoini Composita (1 in 60).

Extract of aloes is contained in Extractum Colocynthidis Compositum (1 in 2¼).

Aloin.—A crystalline principle obtained from aloes.

Characters.—A pale yellow microcrystalline powder, almost inodorous; taste intensely bitter, but tasting of aloes. *Solubility.*—Freely in hot fluids, sparingly in cold water or cold alcohol, not at all in ether. Rapidly altered by alkalies. Aloin is the active principle of aloes, but it does not gripe so much.

Dose, ½ to 2 gr.—3 to 12 centigrms.

Action.

External.—Aloes has no external action on the unbroken skin, but it can be absorbed from a raw

surface, for aloes sprinkled on an ulcer, to which it is a slight stimulant, will lead to purging.

Internal.—*Gastro-intestinal tract.*—In the stomach the bitter principle of aloes causes it to act as a stomachic, like other bitters. In the intestine it increases the rate of the flow of bile, but not the amount secreted. It produces little influence in the small intestine, but the muscular coat of the colon is powerfully stimulated, and the intestinal secretion from that part slightly accelerated. Aloes, therefore, purges, and naturally takes some time, usually fifteen to twenty hours, to act; the motion is well formed, not very soft, as there is so little increased secretion of fluid, and it is dark coloured from the bile in it. Sometimes the drug gripes somewhat, because the muscular contraction it produces is irregular. As it acts chiefly on the lower bowel the habitual use of it may lead to piles. Its emodin makes it an anthracene purgative.

Female genital organs.—Aloes will increase the menstrual flow; it is therefore an emmenagogue. It is excreted by the milk, for aloes given to the mother may purge the child. It is stated also to be excreted in the urine.

Barbados aloes is slightly more purgative than Socotrine aloes, and contains a greater proportion of substances soluble in water.

As a rule aloin acts like aloes, but it does not gripe so much. Some specimens, however, have very little action. This may be owing to adulteration, or differences in their composition.

Therapeutics.

Aloes is an excellent purgative for cases of habitual constipation, many of which are due to an imperfect contraction of the muscular coat of the large intestine. It is very commonly given as a

dinner pill (1 gr., 6 centigrms., of extract of aloes, or $\frac{1}{2}$ gr., 30 milligrms., of aloin and $\frac{1}{4}$ gr., 16 milligrms., of extract of nux vomica) to sufferers from chronic constipation, and in these cases its bitter principles acting as stomachics aid digestion. If the fæces are hard $\frac{1}{2}$ gr. (30 milligrms.) of powdered ipecacuanha should be added. To avoid griping it is well to combine a little extract of hyoscyamus or a little extract of belladonna with it. One great advantage of aloes is that the dose need not be gradually increased. It is also very commonly given as a pill with nux vomica and a grain or two of the dried sulphate of iron to persons suffering from chlorosis and other forms of anæmia. It overcomes the chronic constipation so common in these cases, and some regard this as very important for the cure of the disease. The amenorrhœa so frequently associated with chlorosis is often benefited by aloes, and amenorrhœa due to other causes may also be relieved. Aloes is of great service in many cases of chronic constipation of children. A warm aqueous solution of aloin purges when injected subcutaneously.

Aloes must not be given in pregnancy, hæmorrhoids, or menorrhagia. An enema of it is anthelmintic.

Class III.—**Drastic Purgatives.**

SCAMMONY.

Scammoniæ Radix.—Scammony Root. The dried root of *Convolvulus scammonia.* Syria and Asia Minor.

Characters.—Cylindrical, except at upper end, where it is enlarged, and has remains of aërial stems; shrivelled, contorted, longitudinally furrowed. Externally, greyish brown or yellow. Internally, pale grey or white. Fractured surface very coarsely fibrous. Odour and taste like jalap, faint. *Resembling scammony root.*—Belladonna, which is smaller.

Ipomœæ Radix.—*Synonyms.*—Orizaba Jalap Root, Mexican Scammony Root.

SOURCE.—This is the dried root of Ipomœa Orizabensis.

CHARACTERS.—Irregular, tough fibrous pieces, often in portions of transverse slices of large roots. Externally greyish black, wrinkled. Internally grey or brown. Yields to alcohol a resin which has the properties enumerated under Scammony Resin.

Scammoniæ Resina.—Resin of Scammony. A mixture of resins obtained from scammony root or from Orizaba Jalap root.

SOURCE.—Either root is exhausted with alcohol and the resin is precipitated with water and dried.

CHARACTERS.—Brownish, brittle, translucent pieces; fracture resinous. Odour fragrant. Soluble in ether. Tincture of it does not blue the fresh-cut surface of potato.

COMPOSITION.—The chief constituent is jalapin (*see* p. 513).

IMPURITIES.—Guaiacum resin, which blues potato. Jalap resin insoluble in ether.

Dose, 4 to 8 gr.—25 to 50 centigrms.

Preparation.

Pulvis Scammoniæ Compositus.—Scammony resin, 50; jalap, 35; ginger, 15.

Dose, 10 to 20 gr.—6 to 12 decigrms.

Scammony resin also contained in Extractum Colocynthidis Compositum, Pilula Colocynthidis Composita, Pilula Colocynthidis et Hyoscyami.

ACTION.

Gastro-intestinal tract.—Scammony has no effect till it reaches the duodenum. With the bile it forms a strongly purgative compound, powerfully stimulating the intestinal glands and causing a profuse secretion of intestinal fluids. There is some exaggeration of vascularity, some irregular stimulation of the muscular coat, but these are comparatively slight, and there is little if any addition to the biliary flow.

As a result of these actions, in about four hours there is a profuse watery evacuation of the bowels. The drug is, therefore, a powerful hydragogue cathartic, and in large doses a strong gastro-intestinal irritant. Its action is attended with some griping. It produces no effect if injected into the blood, and therefore acts only locally on the intestine. It is anthelmintic to both roundworms and tapeworms.

Therapeutics.

Scammony being a prompt purgative, obstinate constipation, in either children or adults, may be treated with it. It may also be given as an anthelmintic.

JALAP.

Jalapa.—Jalap. The dried tubercles of *Ipomœa purga.*

Characters.—Irregularly ovoid or oblong, hard, compact roots. Size variable, generally somewhere between a walnut and hen's egg. May be in halves and quarters. Externally dark brown, furrowed, wrinkled with pale lines or scars. Internally dirty yellow or brown, with dark brown irregular circles. Odour smoky, slight. Taste sweetish, acrid, nauseous.

Composition.—The chief constituent is the official *resin.* The Pharmacopœia directs that jalap should contain from 9 to 11 per cent. of the resin.

Dose, 5 to 20 gr.—3 to 12 decigrms.

Preparations.

1. **Pulvis Jalapæ Compositus.**—Jalap, 3; acid tartrate of potassium, 6; ginger 1.

Dose, 10 to 60 gr.—6 to 40 décigrms.

2. **Tinctura Jalapæ.**—Jalap and alcohol (70 per cent.). Percolate. *Standardized to contain between* 1·45 *and* 1·55 *per cent. of jalap resin.*

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

3. Tinctura Jalapæ Composita.—Jalap, 80; scammony resin, 15; turpeth, 10; alcohol (60 per cent.), to produce 1000.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Jalap is contained in Pulvis Scammonii Compositus, 3 in 8.

Jalapæ Resina.—Jalap Resin is a mixture of resins obtained from Jalap.

Source.—Jalap is digested and percolated with alcohol (90 per cent.). From the tincture thus formed the resin is precipitated with water. It is washed and dried.

Characters.—Dark brown, opaque, brittle fragments, translucent at the edges, breaking with a resinous fracture. Odour sweetish. Taste acrid. *Solubility.*—Readily in alcohol (90 per cent.), not in water. *Resembling jalap.*—Aloes, which is bitter.

Composition.—The chief constituents are—(1) *Convolvulin*, a glucoside, a hard substance insoluble in ether, more active than jalapin, and the most abundant active ingredient of jalap. (2) *Jalapin*, a glucoside. Dose, ½ gr. This is a soft resinous substance, soluble in ether. The tubercles of *Ipomœa purga* contain very little, but scammony and other species of Ipomœa contain a considerable amount.

Dose, 2 to 5 gr.—12 to 30 centigrms.

Action.

The mode of action of jalap is precisely the same as that of scammony, with only two exceptions. It causes a greater secretion of intestinal juice, and is therefore more hydragogue; it stimulates the vessels and muscular coat less, and therefore is less irritant and griping.

Therapeutics.

Jalap is very largely used as a hydragogue purgative when we want to draw off large quantities of fluid, therefore it is especially suitable for patients with Bright's disease, for those suffering from uræmia, and for those with dropsy from any cause.

Large doses should not be given if the intestinal mucous membrane is liable to inflame easily. It is occasionally employed for severe constipation.

KALADANA.

Kaladana. *Synonym.*—Pharbitis Seeds. The dried seeds of *Ipomœa hederacea.*

CHARACTERS.—The seeds are in the form of a segment of a sphere, about 5 millimetres long and wide. Black, except at the hilum, where they are brown and hairy.

Dose, 30 to 45 gr.—2 to 3 grms.—in powder.

Preparations.

1. **Pulvis Kaladanæ Compositus.**—Kaladana, 3; acid potassium tartrate, 6; ginger, 1.
   Dose, 10 to 60 gr.—6 to 40 decigrms.
2. **Tinctura Kaladanæ.**—1 in 5 of alcohol (70 per cent.).
   Dose, ½ to 1 fl. dr.—2 to 4 mils.

Kaladanæ Resina. Kaladana Resin. *Synonym.*—Pharbitisin. Is a mixture of resins obtained from Kalanda.

SOURCE.—Exhaust Kaladana with alcohol, precipitate the resin with water and dry.

CHARACTERS.—Brownish opaque fragments, translucent at edges, breaking with a resinous fracture. Insoluble in water, easily soluble in alcohol (90 per cent.).

Dose, 2 to 8 gr.—12 to 50 centigrms.

ACTION AND THERAPEUTICS.

Kaladana resin resembles the convolvulin found in jalap, and kaladana and its resin have the same actions and may be used for the same purposes as jalap. They are used principally in India and the East Indies.

TURPETH.

Turpethum.—The dried root and stem of *Ipomœa turpethum.*

CHARACTERS.—As found in commerce consists of the root and stem cut into short lengths 1 to 5 centimetres in diameter.

Often split on one side with the central woody portion removed. The exterior surface furrowed and dull grey.

Dose, 5 to 20 gr.—3 to 12 decigrms.—in powder.

Preparation.

Tinctura Jalapæ Composita.—Jalap, 80; scammony, 15; turpeth, 10; alcohol (60 per cent.), to produce 1000.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Action and Therapeutics.

The drug is active because of the resin it contains, usually about 10 per cent. This is a glucoside with the same chemical and physiological properties as convolvulin, the active glucoside of jalap. Therefore the actions and uses of turpeth are the same as those of jalap. It is used chiefly in India, the East Indies, and North America.

CROTON OIL.

Oleum Crotonis.—The fixed oil expressed from the seeds of *Croton tiglium*. East Indies.

Characters.—Brownish yellow to dark reddish brown. Sp. gr. 0·94 to 0·96. Odour faint, peculiar, rancid. Taste oily, acrid. *Solubility.*—Freely in alcohol, ether, chloroform, or olive oil.

Composition.—The chief constituents are—(1) Several volatile acids (1 per cent. in all); these give the odour. (2) Tiglic or methyl crotonic acid, $C_5H_8O_2$. (3) Glyceryl of crotonoleic acid, $C_9H_{14}O_2$. This appears to be the active principle. (4) Several fatty acids, both free and combined to form fats. (5) Crotonol, a substance which is non-purgative, but is capable of causing some cutaneous irritation.

Dose, ½ to 1 m.-3 to 6 centimils—on a lump of sugar, or mixed with butter or vaseline and placed at the back of the mouth, so that it may be quickly swallowed.

Preparation.

Linimentum Crotonis.—Croton oil, 12; oil of cajuput, 44; alcohol (90 per cent.), 44.

(Croton seeds are not official, but it is important to recognize them. They are ½ in. long, ⅓ in. broad, ovoid and bluntly

oblong, covered with a brown shell, which on scraping becomes black. The kernel is white and oily. They yield 50 to 60 per cent. of croton oil. They are known from castor-oil seeds, which are like them, by the fact that the castor-oil seeds are bright, polished, and mottled.)

Action.

External.—Croton oil is one of the most powerful irritants in the Pharmacopœia. A drop placed on the skin causes redness, burning pain, and quickly a crop of vesicles forms (vesication); these rapidly become pustules (pustulation), and the surrounding subcutaneous tissue is red and œdematous.

Internal.—*Gastro-intestinal tract.*—Very soon after a drop has been taken there is considerable griping and abdominal pain. In an hour or two the bowels are opened, and this may subsequently occur several times, the motions becoming more and more fluid. The croton oil greatly aggravates the vascularity of the stomach and intestines, the mucous membrane of which becomes red, œdematous, and angry-looking; there is a great increase of the intestinal secretion, but none of the bile. The drug produces, in fact, severe enteritis, and to a less extent gastritis. The motions may contain blood. These effects are all due to the crotonoleic acid, which resembles the ricinoleic acid of castor oil, but is much more powerful and is much more easily set free from croton oil, hence the external irritant action of the oil. It is probable that the peristaltic movements are increased also. Croton oil applied to the skin may cause free purgation, the acid being excreted into the bowel.

Therapeutics.

External.—Croton oil was formerly employed externally as an irritant and counter-irritant for inflamed joints, pleurisy, bronchitis, and phthisis; but it is not often so used now, as the scars left after

the suppuration are very unsightly, the application is too painful, and the inflammation induced too severe. A little croton oil spread over an area not exceeding that of a sixpence may be applied to set up suppuration in the scalp, and so to destroy an inveterate patch of ringworm, if it is wished to cure it quickly. The croton oil will certainly do this, but the resulting suppuration is so severe that the remedy should be used with care, and only when all others have failed. The liniment, well diluted, is occasionally employed to stimulate the skin in alopecia.

Internal.—Croton oil should only be given in very obstinate constipation not due to organic obstruction, and only one dose should be administered Not more than one or two drops should be prescribed. Constipation due to lead poisoning and fæcal impaction are sometimes suitable cases. Placed on the back of the tongue, it is, on account of its small bulk, a useful purgative for lunatics who refuse to take anything, and for unconscious patients, because in such cases it is swallowed reflexly and acts quickly, and therefore it is commonly given to those who are unconscious from apoplexy, but it must be diluted by mixture with sugar or butter to prevent local inflammation of the tongue. It should never be administered to children, to pregnant women, to feeble subjects, to those with hæmorrhoids, nor to those suffering from peritonitis, gastritis, or enteritis.

Croton-oil seeds contain a poisonous toxalbumin crotin, which resembles ricin (*see* p. 500).

COLOCYNTH PULP.

Colocynthidis Pulpa.—The dried pulp of the fruit of *Citrullus colocynthis*, freed from seeds. *Synonym.*—Bitter calumba. Imported from Smyrna. Trieste, France, and Spain.

Characters.—More or less broken, whitish, very light, spongy, tough balls, about 2 in. in diameter, consisting of

the pulp in which the seeds are embedded. The broken-up pulp without the seeds is alone official. This is light, spongy, whitish, odourless, with an intensely bitter taste.

IMPURITIES.—Seeds and cortex.

COMPOSITION.—The chief constituents are—(1) *Colocynthin*, an amorphous or crystalline, bitter, active glucoside, readily soluble in water and alcohol. (2) Resinous matter having the names of citrullin, colocynthein, and colocynthitin, insoluble in water.

Preparations.

1. Extractum Colocynthidis Compositum.—Colocynth pulp, 150; extract of aloes, 300; resin of scammony, 100; curd soap, 75; cardamoms, 25; alcohol (60 per cent.), 4000.

Dose, 2 to 8 gr.—12 to 50 centigrms.

2. Pilula Colocynthidis Composita.—Colocynth pulp, 20; aloes, 35; resin of scammony, 35; potassium sulphate, 5; oil of cloves, 5; water, q.s.

Dose, 4 to 8 gr.—25 to 50 centigrms.

3. Pilula Colocynthidis et Hyoscyami.—Pilula colocynthidis composita, 2; extract of hyoscyamus, 1; water, q.s.

Dose, 4 to 8 gr.—25 to 50 centigrms.

ACTION.

In small doses colocynth acts as a simple bitter, increasing the gastric and intestinal secretions and improving the appetite. In larger doses it augments the flow of bile and succus entericus considerably, stimulates the muscular coat, causes a little griping, and leads to the evacuation of a watery motion. In still larger doses the hypersecretion is excessive and the griping is severe because the muscular coat is powerfully irritated, and several abundant watery motions result. The drug may therefore be called drastic, hydragogue, and cathartic. The depression produced may be considerable.

THERAPEUTICS.

Colocynth should never be given alone, because of the griping it causes. In the colocynth and hyoscyamus pill, which is often prescribed, the hyoscyamus prevents this painful result. Colocynth is an excellent purgative for producing a single abundant evacuation of the bowels in chronic constipation, such as that so often met with in persons suffering from hepatic disorder, and in those confined to bed. Because of the watery character of the motions it may be given in ascites or Bright's disease, but jalap or scammony is usually preferred. It is too irritant for habitual use. It should never be administered if there is any suspicion of intestinal or gastric inflammation, nor in pregnancy. It is often combined with milder purgatives. A diuretic action has been claimed for it, but this is unimportant.

CLASS IV.—Cholagogues.

PODOPHYLLUM.

Podophylli Rhizoma.—Podophyllum Rhizome. The dried rhizome and roots of *Podophyllum peltatum*, the American May-apple. Imported from North America.

CHARACTERS.— Pieces of variable length and about 5 millimetres thick, cylindrical, with at intervals of 5 centimetres tuberosities, which are marked above by a depressed circular scar, and give off below a number of very brittle brownish rootlets, or show, if these are broken off, a corresponding number of whitish scars; externally dark reddish brown, smooth or wrinkled; fracture short; internally whitish and mealy or yellowish brown and horny. Odour faintly narcotic. Taste bitterish, acid, nauseous.

COMPOSITION.—The chief constituents are—(1) The alkaloid *berberine*. (2) The official *resin*, which is the purgative principle.

Podophylli Resina.—Podophyllum Resin.
Synonym.—Podophyllin
SOURCE.—Extract the root by percolation with alcohol

(90 per cent.), and precipitate the resin with water acidulated with hydrochloric acid. Wash and dry.

CHARACTERS.—A pale yellow to deep orange-brown amorphous powder, soluble in alcohol and ammonia.

COMPOSITION.—Podophyllum resin contains at least two other resins, one soluble and the other insoluble in ether. These resins contain an active purgative crystalline body, podophyllotoxin. This, it is said, can be split up into picro-podophyllic acid, which is inert, and picro-podophyllin, a crystalline neutral body, the active principle. Both these also exist free in the rhizome.

INCOMPATIBLES.—Water precipitates it from alcohol, acids precipitate it from ammonia.

Dose, $\frac{1}{4}$ to 1 gr.—16 to 60 milligrms.

Preparation.

Tinctura Podophylli.—Resin of podophyllum, 36·5; alcohol (90 per cent.), 1000. Macerate.

Dose, 5 to 15 m.—3 to 10 decimils.

ACTION.

External.—It has no external action unless applied to raw surfaces, from which it may be absorbed and then it will purge.

Internal.—*Gastro-intestinal tract.*—Podophyllum has a bitter taste. It is in large doses a powerful gastro-intestinal irritant, and has caused death. In medicinal doses it gives rise to much griping pain, perhaps some nausea, and in about ten hours there is an **evacuation of the bowels**; the motion, which is liquid, is deeply stained with bile. The pain shows that the muscular coat is stimulated, the liquidity that probably an excess of intestinal fluid is secreted, and the colour that the drug is an indirect cholagogue (p. 102). In small doses podophyllum is by some believed to increase the secretion of bile, and certainly the solids in it are greater; in purgative doses it is said not to increase the quantity, but that more bile is poured from the gall-bladder into the intestine. It probably acts after absorption,

for all its effects can be produced if it is injected subcutaneously.

THERAPEUTICS.

Podophyllum is only used for its cholagogue purgative action. It is especially suitable for constipation due to hepatic disorder, whether functional, as in the hepatic dyspepsia which commonly goes by the name of biliousness, or organic, as in hepatic cirrhosis and cancer. It must be remembered that, as it causes much griping, it should be combined with hyoscyamus or some other drug to overcome this; that it takes a long while to act, and will therefore be swept away before it has produced any effect if given with quickly acting purgatives; and that it is better to begin with small doses, as people are very unequally affected by it. It may be advantageously combined with calomel in a pill. It is so disagreeable to the taste that it is better to dissolve the resin in aromatic spirits of ammonia (1 gr. to 1 fl. dr., 6 centigrms. to 4 mils) than to use the pharmacopœial tincture, as water does not precipitate the resin from ammonia, but it does from the pharmacopœial tincture.

INDIAN PODOPHYLLUM.

Podophylli Indici Rhizoma.—The dried rhizome and roots of *Podophyllum emodi*.

CHARACTERS.—Rhizome, more or less cylindrical and contorted, about 10 millimetres thick, crowned with remains of aerial stems bearing cup-shaped scars, below numerous root scars or stout roots. Faint odour, bitter taste.

Officially used in India and Eastern Colonies.

Podophylli Indici Resina.—A powdered resin prepared from Indian *Podophyllum rhizome*, and resembling the other variety of *Podophyllum resin*.

Dose, ¼ to 1 gr.—16 to 60 milligrms.

Preparation.

Tinctura Podophylli Indici.—Indian podophyllum resin, 36·5; alcohol (90 per cent.), 1000.

Dose, 5 to 15 m.—3 to 10 decimils.

ACTION AND THERAPEUTICS.

Indian podophyllum has precisely the same actions and uses as the other variety.

EUONYMUS BARK.

Euonymi Cortex.—Euonymus Bark. The dried root-bark of *Euonymus atropurpureus*. *Synonyms.*—Wahoo, spindle-tree, hominy bush. United States.

CHARACTERS.—Incurved or quilled pieces, 2 to 4 millimetres thick. Colour light ash-grey with darker patches. Inner surface tawny white and smooth, when freed from fragments of white wood. Taste at first sweet, then bitter and acid.

COMPOSITION.—The chief constituents are (1) *euonymin*, a resin, (2) asparagin, and (3) euonic acid.

Preparation.

Extractum Euonymi (commonly called euonymin).—Euonymus bark, in powder, is percolated with alcohol (45 per cent.); the liquid is evaporated till a brown dry powder is left, which is incorporated with a quarter of its weight of calcium phosphate, the object of which is to prevent it from agglutinating. It must be kept in a well stoppered bottle.

Dose, 1 to 2 gr.—6 to 12 centigrms.

This is Extractum Euonymi Siccum, B. P. 1898.

ACTION AND THERAPEUTICS.

In small doses euonymin stimulates the appetite and the flow of gastric juice. In larger it is irritant to the intestine and is cathartic. It is an indirect cholagogue (p. 102), but does not gripe or cause much intestinal secretion. Some state that it increases the solids of the bile. It has slight diuretic

and expectorant effects, but its only use is as a purgative for those cases of constipation in which the liver is disordered, and for which it is particularly efficacious. It is usually combined in a pill with other cholagogues, as iridin and calomel.

Iridin.—(Not official.)

Synonym.—Irisin. This is the Extractum Iridis (B.P.C.). It is the powdered resin obtained by extraction from the root of *Iris versicolor*, the blue flag. Britain.

CHARACTERS.—A dark brown, bitter, nauseous powder.

Dose, 1 to 3 gr.—6 to 20 centigrms.—in a pill with glycerin of tragacanth or extract of henbane.

ACTION AND THERAPEUTICS.

Iridin is an indirect cholagogue, formerly believed to increase the biliary solids, and as it rarely gripes it may be given when it is required to use a cholagogue purgative daily for some time. It may be combined with euonymin, calomel, podophyllin, and other cholagogue purgatives.

GROUP VI.

Volatile Oils.

These, when applied externally, stimulate the skin, and thus cause **redness**, sometimes even vesication, tingling, and subsequent numbness. Taken internally, they stimulate the gastro-intestinal tract, increasing its vascularity, the flow of saliva, of gastric juice, and of succus entericus; and they are commonly said to excite its unstriped muscular fibres, but there is evidence that they diminish griping by lessening and regulating muscular contraction. Thus in moderate doses they are **stomachics** and **carminatives**; in large doses they are gastro-intestinal **irritants**. Their irritation of the stomach reflexly stimulates the heart and the central nervous system. They are absorbed and excreted by the skin, which they may thus irritate, and by the bronchial mucous membrane, which they consequently stimulate, increasing the amount of secretion from it, its vascularity, the expulsive power of its unstriped

muscle, and reflexly this irritation leads to coughing; consequently they are **expectorants.** They are also largely excreted by the kidneys, which are stimulated even to inflammation, and hence these drugs are often **diuretic**; and by the **genito-urinary mucous membrane**, which is also stimulated, often so energetically that it becomes inflamed. Some volatile oils act strongly in all these ways; others act much more powerfully in some than in others. They will be classified according to the tissue on which they chiefly act, or for the action for which they are mostly used.

Class I.—Volatile oils (or substances containing them) acting chiefly upon, or used chiefly for their stimulation of, the **skin.**

Oil of Turpentine, Tar, Oil of Cade, Resin, Canada Balsam, Oil of Mustard, Oil of Cajuput, Oil of Eucalyptus, Oil of Rosemary, Arnica Flowers, Oil of Lemon Grass.

Class II.—Volatile oils (or substances containing them) acting chiefly upon, or used chiefly for their stimulation of, the **gastro-intestinal tract.**

Pyrethrum, Cloves, Pepper, Nutmeg, Cinnamon, Oliver Bark, Horseradish, Capsicum, Ginger, Cardamoms, Oil of Lavender, Oil of Peppermint, Oil of Spearmint, Anise, Coriander, Fennel, Caraway, Dill, Chamomile, Rose, Betel.

Class III.—Volatile oils (or substances containing them) acting chiefly upon the stomach, so as to reflexly stimulate the **heart and central nervous systems**, or chiefly used for this purpose.

Valerian, Asafetida, Ammoniacum, Myrrh.

Class IV.—Volatile oils (or substances containing them) acting chiefly upon, or used chiefly for their stimulation of, the **bronchial mucous membrane.**

Terebene, Balsam of Peru, Balsam of Tolu, Storax, Oleum Abietis, Oleum Allii.

Class V.—Volatile oils (or substances containing them) acting chiefly upon, or used chiefly for their stimulation of, the **kidneys and genito-urinary tract.**

Oil of Juniper, Buchu, Copaiba, Cubebs, Oil of Sandal wood.

Class I. of **Volatile Oils.**

Those used chiefly for their action on the skin.

OIL OF TURPENTINE.

Oleum Terebinthinæ Rectificatum.—Rectified Oil of Turpentine. The oil distilled, from the oleo-resin (common turpentine) exuding from various species of *Pinus* and rectified.

Characters.—Limpid, colourless. Odour strong, peculiar. Taste pungent, bitter. Neutral. Mixes with other volatile and fixed oils. Dissolves resins (the solution forms varnish), wax, sulphur, phosphorus, and iodine. *Solubility.*—Not at all in water, 1 in 6½ of alcohol (90 per cent.), 3 in 10 of ether, and in all proportions in absolute alcohol, bisulphide of carbon, and chloroform. It is easily oxidized. Old oil of turpentine is an ozonizing agent; it readily absorbs oxygen, and becomes converted into an oleo-resin. French oil of turpentine is lævo-rotatory, some of it comes from *P. maritima*; English oil of turpentine, which mostly comes from America, and Russian oil of turpentine are dextro-rotatory.

Composition.—Oil of turpentine is a mixture of (1) several isomeric hydrocarbons (*terpenes*), all having the formula $C_{10}H_{16}$. The chief of them found in the oil are pinene, phellandrene, limonene, and dipentene. They vary in their boiling-points and the direction in which they rotate the plane of polarization. The principal terpene in American oil of turpentine is dextropinene; the principal terpene in French oil of turpentine is lævopinene. (2) Sesquiterpenes, $C_{15}H_{24}$. (3) Bornyl acetate. Most turpentine contains about 15 per cent. of oil of turpentine. Many official volatile oils, *e.g.* those of lavender, peppermint, chamomile, caraway, cloves, contain various terpenes, all isomeric, and all having the formula $C_{10}H_{16}$. An oxidation product of terpene is camphor, $C_{10}H_{16}O$, which is pharmacopœial (*see* p. 639). Sanitas (p. 528) is another product of the oxidation of a terpene.

Dose, 2 to 10 m.—12 to 60 centimils, or **3 to 4 fl. dr.—12 to 15 mils** (anthelmintic).

1 fl. dr. of mucilage with thorough trituration emulsifies ½ fl. dr. of oil of turpentine with 1 fl. oz. of water.

Preparations.

1. Linimentum Terebinthinæ.—Oil of turpentine, 650; camphor, 50; soft soap, 75; water, to 1000.

2. Linimentum Terebinthinæ Aceticum.—Glacial acetic acid, 110; liniment of camphor, 445; rectified oil of turpentine to produce 1000.

Action.

External.—Oil of turpentine has to a marked degree the action of other volatile oils. Thus, applied to the skin, especially if rubbed in, it causes the vessels to dilate, there is a sense of warmth, the part becomes red, and subsequently common sensation is blunted. This oil is therefore **rubefacient, irritant, and counter-irritant.** If enough is applied it is a vesicant. Like the other volatile oils it is **antiseptic and disinfectant.** It is absorbed by the unbroken skin.

Internal.—*Alimentary canal.*—Oil of turpentine has the same stimulant effect when locally applied to the mouth and pharynx as it has on the skin, and in the stomach it powerfully dilates the vessels, increases gastric secretion, co-ordinates peristalsis, lessens griping, and reflexly stimulates the heart, but on account of its nauseous taste it is not used for these properties, which it has in common with other volatile oils. Its effects on the intestine are the same as those on the stomach, hence it is a strong carminative, expelling gas from the bowels. A very large amount leads to **purging**, the motions sometimes containing blood, hæmorrhage resulting from the great vascular dilatation. Oil of turpentine is **anthelmintic**, killing the tapeworm when administered in doses of 2 to 4 fl. dr. (8 to 16 mils); but this treatment may cause severe symptoms. When given as an enema it kills the threadworm.

Circulation.—Oil of turpentine is readily absorbed. Formerly it was thought to stimulate the heart, but any action in this direction is very slight. It contracts the vessels, acting on the vaso-motor centre, and for this reason and because, locally applied to a bleeding vessel, it clots the blood, it is a **hæmostatic.** The blood-pressure rises. After a large dose of any variety this stimu-

lation is followed by depression, the heart beats feebly, the vessels dilate, and blood-pressure falls.

Respiration.—When inhaled, oil of turpentine acts on the bronchial mucous membrane as it does on the skin, irritating it, dilating the vessels, increasing and disinfecting the secretion, stimulating the muscles of the bronchi, and reflexly exciting cough. If given internally, as some of it is excreted by the bronchial mucous membrane, similar effects are produced. At the same time the activity of the respiratory movements is increased from central stimulation, so that the drug is a powerful expectorant.

Nervous system.—Oil of turpentine in large doses is a severe depressant to the nervous system, producing languor, dulness, sleepiness, and unsteady gait. Toxic doses cause coma and paralyse the sensory nerves; consequently reflex action is abolished.

Kidneys.—It acts more powerfully on these than almost any other volatile oil. Even moderate doses may lead to pain in the loins, scanty high-coloured urine, albuminuria, and hæmaturia. The urinary passages are also irritated; consequently, owing to muscular spasm, there is difficulty in passing water, micturition is painful, and a sensation of heat in the perinæum is present (these symptoms constitute strangury). If a large dose has been given the urine may be completely suppressed. Turpentine causes the urine to smell of violets. Some of it is excreted unchanged, some in combination with glycuronic acid.

Skin.—Oil of turpentine is excreted by the skin, and may cause an erythematous rash.

Some is excreted by the respiratory mucous membrane, the milk, bile, and intestinal mucous membrane.

It is said to be a mild antipyretic. Oil of turpentine is an antidote to phosphorus, and it is stated

that old oil of turpentine and French oil of turpentine are preferable, but this is doubtful.

Therapeutics.

External.—Oil of turpentine is very largely employed as an irritant or counter-irritant in various forms of chronic inflammation, such as osteo-arthritis, bronchitis, or pleurisy. The liniments form useful applications. They may also be rubbed in over painful areas, as in neuralgia, myalgia, rheumatic pains, and lumbago. Sometimes it is used as a parasiticide for ringworm. Sanitas is an aqueous solution of common turpentine, which has been allowed to oxidize in the air. Its active antiseptic principle is peroxide of hydrogen (*see* p. 128), and it contains a little thymol. It is a very pleasant disinfectant, but is not so strong as carbolic acid.

Internal.—*Stomach and Intestines.*—Oil of turpentine is not often prescribed for its carminative and stomachic effects, though given either by the mouth or as an enema (1 fl. oz., 30 mils, to 15 fl. oz., 450 mils, of mucilage of starch) it is often very efficacious in removing the intestinal distension due to gas. If it is used as an anthelmintic, 2 to 4 fl. dr. (8 to 16 mils) emulsified in mucilage and followed by a dose of castor oil should be given. Sometimes it promptly relieves gastric or intestinal hæmorrhage, such as that due to gastric ulcer or typhoid fever. Whenever it is prescribed as a hæmostatic, considerable doses, 30 to 60 ♏ (2 to 4 mils) suspended in mucilage, should be administered every hour for a few hours.

Circulation.—It is not employed to influence this except as a hæmostatic. It has had the reputation of being fairly efficacious in arresting hæmorrhage.

Respiration.—It is not much used as an inhalation, for the vapour of Oleum Abietis (*see* p. 570) is

pleasanter; but it might be employed to disinfect foul bronchial secretions, and to stimulate the mucous membrane in chronic bronchitis.

It should be remembered that oil of turpentine must be given internally with great care because of its liability to cause inflammation of the kidneys; indeed, this fact and its nasty taste account for its not being so often administered as would otherwise be the case. It should never be given to the subjects of Bright's disease.

TAR.

Pix Liquida.—Wood Tar. A bituminous liquid obtained from the wood of *Pinus sylvestris*, and other species of *Pinus* by destructive distillation. Known in commerce as Stockholm tar.

CHARACTERS.—Brownish-black semi-liquid substance. Odour peculiar, aromatic. Water shaken with it acquires a pale brown colour, empyreumatic taste, and acid reaction. *Solubility.*—1 in 10 of alcohol (90 per cent.), slightly in oil of turpentine or olive oil, 1 in 3 of a solution of caustic soda. On distillation it gives off an empyreumatic oil (oil of tar), which is official in the United States, and pyroligneous acid. What remains behind is pitch. This is black, solid, melting in boiling water.

COMPOSITION.—Wood tar is a very complex substance. The chief constituents are—(1) *Oil of turpentine* (*see* p. 525). (2) *Creosote* (*see* p. 342). (3) Phenols (*see* p. 335). (4) Pyrocatechin. (5) Acetic acid. (6) Acetone. (7) Xylol. (8) Toluol. (9) Methylic alcohol. (10) Resins.

Dose, 10 to 30 m.—6 to 18 decimils—in the form of pills.

Preparation.

Unguentum Picis Liquidæ.—Wood tar, 70; prepared lard, 5; yellow beeswax, 25.

In India prepared suet should be used instead of prepared lard.

Pix Carbonis Præparata.—Prepared coal tar.

SOURCE.—Commercial coal tar is stirred and heated at 50°C. for 1 hour.

Characters.—A nearly black, viscous liquid, brown in very thin layers. Heavier than water. Strong characteristic odour. Soluble in benzene and chloroform, very slightly in water.

Composition.—It contains chiefly—(1) Benzene and homologous hydrocarbons. (2) Phenols. (3) Solid hydrocarbons, as naphthalene and anthracene.

Preparation.

Liquor Picis Carbonis.—Quillaia bark, 10, is percolated with alcohol (90 per cent.), 100. To the percolate is added prepared coal tar, 20. When, in prescribing, water is added to this solution of tar the quillaia helps to suspend the precipitated tar.

Action.

External.—Tar has precisely the same actions as oil of turpentine, but is not so powerful, therefore the vascular dilatation rarely proceeds to the stage of vesication; but pustules may result if the tar is rubbed in.

Internal.—It is very liable to upset digestion; in large doses it causes epigastric pain, vomiting, severe headache, dark urine, and other symptoms of carbolic acid poisoning (*see* p. 340). Some of its constituents are excreted by mucous membranes, especially the bronchial, on which it acts as a disinfectant stimulating expectorant.

Therapeutics.

External.—Tar ointment, which is rather hard, and may be softened by replacing half the wax with almond oil, is often applied as a stimulant to chronic skin diseases, such as psoriasis and chronic eczema. Because of its mildly local anæsthetic action, it is sometimes useful in pruritus.

Liquor Picis Carbonis is a favourite preparation for many skin diseases. It is an imitation of the popular Liquor Carbonis Detergens, which is an alcoholic solution of ordinary coal tar.

Internal.—Coal tar is rarely prescribed for internal use. Wood tar is only given as an expectorant, and it is very valuable for chronic bronchitis. It may be prescribed as a pill, as perles, or as the Syrupus Picis Liquidæ (B. P. C., dose 1 to 2 fl. dr.—4 to 8 mils), or as Vinum Picis (a saturated solution of wood tar in sherry, dose 1 to 4 fl. dr.—4 to 16 mils), or as the French preparation eau de goudron. Tar water is made by stirring a pint of wood tar with half a gallon of water for fifteen minutes and decanting. The dose is a pint daily. It may be used externally as a wash. The Syrup of Liquid Tar with Syrup of Virginian Prune (*see* p. 473) and $\frac{1}{20}$ gr. (3 milligrms.) of Apomorphine hydrochloride forms an excellent cough mixture.

OIL OF CADE.

Oleum Cadinum.—*Synonyms.*—Huile de cade, Juniper tar oil. An empyreumatic oily liquid obtained by the destructive distillation of the woody portions of *Juniperus oxycedrus.*

Characters.—An empyreumatic, dark reddish-brown, viscid, oily liquid. Odour smoky, tar-like. Taste aromatic. Sp. gr. 0·99. *Solubility.*—Freely in ether and chloroform, partly in alcohol, not in water. Mixes readily with fats and fixed oils.

Composition.—Probably similar to that of wood tar.

Action and Therapeutics.

Oil of cade has the same action on the skin as tar, but it is preferable, as the odour is pleasanter. The diseases treated by the application of it are psoriasis, chronic eczema, and pruritus. A usual formula is oil of cade 1, soft soap 4, alcohol (90 per cent.) 4, but an ointment (Unguentum Olei Cadini, B. P. C.) made by melting it with an equal part of yellow wax is a more agreeable preparation.

RESIN.

Resina. *Synonym.*—Rosin. The residue left after distillation of oil of turpentine from the crude oleo-resin (crude turpentine) of various species of *Pinus*.

CHARACTERS.—Translucent, yellowish, brittle, pulverizable. Fracture shining. Odour and taste like turpentine. Burns with a yellow flame and much smoke. Soluble in alcohol, ether, alkalies, and carbon bisulphide.

COMPOSITION.—The chief constituent is abietic acid, $C_{18}H_{27}\cdot COOH$, a crystalline substance.

Preparations.

1. **Emplastrum Resinæ.** *Synonym.*—Adhesive plaster. Resin, 10; lead plaster, 85; hard soap, 5.

2. **Unguentum Resinæ.** *Synonym.*—Basilicon ointment. Resin, 26; yellow beeswax, 26; olive oil, 26; prepared lard, 22. In India prepared suet should be used instead of prepared lard.

Resin is contained in many plasters.

ACTION AND THERAPEUTICS.

Resin is antiseptic and slightly stimulant, and is, therefore, an excellent application for indolent ulcers, sores, and wounds.

CANADA BALSAM.

Terebinthina Canadensis.—Canada Turpentine, or Canada Balsam. The oleo-resin obtained from *Abies balsamea*. Canada.

CHARACTERS.—It is pale yellow, faintly greenish, transparent, fluid, of the consistency of thin honey. Odour peculiar, agreeable. Taste slightly bitter. It slowly dries, forming a transparent varnish. Readily soluble in ether, chloroform, or spirit.

COMPOSITION.—It is an oleo-resin, and contains oils and resins isomeric with those of ordinary turpentine and resin.

Canada balsam is contained in Collodium Flexile.

Action and Therapeutics.

Canada balsam is rarely used except for its physical property of drying to form an adhesive varnish. It has the same action as oil of turpentine.

MUSTARD OIL.

Oleum Sinapis Volatile.—The volatile oil distilled from black mustard seeds deprived of most of their fixed oil and macerated in water for several hours.

Characters.—Pale yellow or colourless; intensely pungent and irritant. Sp. gr. 1·014 to 1·025. *Solubility.*—1 in 50 of water, readily in spirit and in ether.

Composition.—The Pharmacopœia directs that it contain not less than 92 per cent. of *Allyl isothiocyanate*, C_3H_5NCS.

Preparation.

Linimentum Sinapis.—Volatile oil of mustard, 35; camphor, 55; castor oil, 125; alcohol (90 per cent.), to 1000.

Action.

External.—Mustard is a typical powerful local **irritant**. Thus it first produces dilatation of the vessels, which causes redness of the skin (**rubefacient** effect) and a sensation of **warmth**. Because of the irritant action of mustard on the sensory nerves, a severe **burning** pain is soon felt. This irritation of the nerves is followed by their paralysis, consequently there is a local loss of **sensibility**, and a diminution both of the pain produced by the mustard and of any that may have been present before its application. The irritation of the vessels leads to the transudation of plasma through them; this, collecting under the epidermis, raises it, and thus vesicles, blebs, or blisters are formed (vesicant effect). Mustard is also a **counter-irritant** (*see* p. 60): that is to say, the stimulation of the cutaneous nerves reflexly leads to an alteration in the size of the vessels of the viscera under the seat of application.

This excitation of the sensory nerves is sufficiently powerful to reflexly stimulate the heart and respiration, and sometimes to restore consciousness after fainting.

Internal.—*Gastro-intestinal tract.*—Mustard also acts here as an irritant. Taken in the usual small quantities as a condiment, it causes a sense of warmth in the stomach, it moderately stimulates the secretion of gastric juice, and therefore sharpens the appetite. A dose of one to four teaspoonfuls stirred up in a tumbler of water is sufficiently irritating to be a direct stomachic emetic, causing prompt vomiting without the depression which usually attends emetics, because the mustard reflexly stimulates the heart and respiration.

Therapeutics.

External.—A poultice made with linseed and having a little mustard (1 part to 16 of linseed) sprinkled on it is a very common and efficacious application as an irritant and counter-irritant in rheumatism, pleurisy, pneumonia, bronchitis, pericarditis, and many inflammatory diseases. In the manner already explained it will, when applied to the skin, soothe pain in gastralgia, colic, painful diseases of the chest, neuralgia, and lumbago. The paper or any of the mustard leaves that are sold, moistened in water, form an excellent application. Often the local application of mustard over the stomach relieves vomiting. A large mustard poultice applied to the legs was formerly used as a reflex stimulant in cases of syncope, asphyxia, and coma.

Common colds and febrile conditions, especially in children, are often treated by placing the feet and legs or the whole body in mustard and warm water (10 to 15 ounces of mustard to every 15 gallons of water, as hot as can be borne), the object being by the cutaneous dilatation to withdraw blood from the

inflamed part. A mustard sitz bath may be taken at the period to induce menstruation.

Internal.—Mustard is used as a condiment, and also as an emetic. It is especially valuable for poisoning by narcotics, because of its reflex stimulant effects.

Thiosinamin.—(Not official.)

This is the usual name for Allylthiocarbamide, $C_4H_8N_2S$.

Source.—It is prepared by warming oil of mustard with alcoholic solution of ammonia. *Solubility.*—1 in 18 water, 1 in 2 alcohol, 1 in 10 glycerin.

Dose, internally or subcutaneously, **$\frac{1}{2}$ to $1\frac{1}{2}$ gr.—3 to 10 centigrms.**

It has been largely used because it has been stated to soften cicatricial fibrous tissue. Thus it is given in cases of fibrous stricture of the œsophagus, pylorus, or urethra. Also for Dupuytren's contracture, parametritis, contracture due to scars, and deafness due to chronic fibrous conditions in the middle ear. In some cases a certain improvement is said to follow its use, in others none ensues. It is usually given as **Fibrolysin**, which consists of thiosinamin and sodium salicylate in solution. This is injected subcutaneously or intramuscularly every other day, beginning with 20 ♏ and increasing the dose to 40 for each injection. As it does not keep after exposure to air it is sold in ampullæ or glass bulbs.

CAJUPUT OIL.

Oleum Cajuputi.—The oil distilled from the leaves of *Melaleuca leucadendron* and other species of *Melaleuca.* Batavia and Singapore.

Characters.—A transparent, very volatile, limpid, pale bluish-green liquid, with a strong, penetrating, camphoraceous odour. Taste warm, bitter, aromatic, camphoraceous, and succeeded by a sensation of coldness. Floats on water. Sp. gr. 0·919 to 0·930. Readily soluble in alcohol.

Composition.—The chief constituents are—(1) Hydrate of cajuputene, or *cineol*, isomeric with Borneo camphor (*see* p. 640), 75 per cent. This is found in oil of eucalyptus (*see p.* 536) and other volatile oils. (2) Another oil.

Impurities.—Other oils and copper.

Dose, $\frac{1}{2}$ to 3 m.—3 to 18 centimils.

Preparation.

Spiritus Cajuputi.—Oil of cajuput, 1; alcohol (90 per cent.), 9.

Dose, 5 to 20 m.—3 to 12 decimils.

Oil of cajuput is contained in Linimentum Crotonis.

Action.

The action of cajuput oil is exactly the same as that of the oil of cloves (*see* p. 541).

Therapeutics.

External.—Cajuput oil is used as a stimulant, irritant, and counter-irritant—usually diluted with sweet oil—for all sorts of purposes when any of these effects are needed. Thus it is rubbed in for chilblains, myalgia, rheumatic pains, chronic inflammatory conditions of the joints or periosteum. It has also been employed as a parasiticide for *Tinea tonsurans*. The only objection to its use is its strong smell.

Internal.—It is occasionally given in dyspepsia, usually combined with other remedies, for the sake of its carminative, stomachic, and antispasmodic effects; it may be taken on sugar.

OIL OF EUCALYPTUS.

Oleum Eucalypti.—The oil distilled from the fresh leaves of *Eucalyptus globulus*, the blue gum tree, *Eucalyptus dumosa*, and other species of *Eucalyptus*. Australia.

Characters.—Colourless or pale straw-coloured, becoming darker and thicker by exposure. Odour aromatic. Taste spicy, pungent, leaving a sensation of coldness in the mouth. Neutral. Sp. gr. 0·910 to 0·930. *Solubility.*—In an equal weight of alcohol. The oils from different species of *Eucalyptus* vary very much.

Composition.—The chief constituents are—(1) A volatile oil, *eucalyptol*, about 70 per cent. It is that portion which in distillation passes over between 160° and 177°C. It is a mixture of (*a*) an irritating terpene called phellandrene, $C_{10}H_{16}$, and (*b*) cymene, $CH_3 \cdot C_6H_4 \cdot CH(CH_3)_2$. It is met with in commerce. (2) A crystallizable resin, probably derived from the oil, and

yielding ozone. (3) Tannin. (4) An oil, *cineol*, isomeric with hydrate of cajuputene (*see* p. 535). It is met with in commerce, and is called eucalyptol, or more properly crystallizable eucalyptol, as it solidifies at 0°C. It is found in many volatile oils.

INCOMPATIBLES.—Alkalies, mineral acids, metallic salts.

Dose, ½ to 3 m.—3 to 18 centimils.

Preparation.

Unguentum Eucalypti.—Oil of eucalyptus, 1 white soft paraffin, 5 ; hard paraffin, 4.

ACTION.

External.—Oil of eucalyptus is much less irritant when applied externally than other volatile oils, but if its vapour is confined it will produce vesication and pustulation. It is powerfully antiseptic and disinfectant. Old oil is more antiseptic than new, probably from the greater amount of ozone it contains.

Internal.—*Gastro-intestinal tract.*—In medicinal doses oil of eucalyptus is stomachic, having the same actions as oil of cloves. In large doses it produces severe gastro-intestinal irritation, as shown by vomiting, diarrhœa, and abdominal pain.

Circulation.—It, like quinine, arrests the movements of the white blood-corpuscles ; and it likewise resembles this drug in its antipyretic and its anti-periodic actions, and also, it is said, in causing contraction of the spleen ; but quinine is in all respects the more energetic. In medicinal doses the heart is stimulated by oil of eucalyptus, and the blood-pressure rises ; probably these effects are reflex from the stomach. After large quantities the action of the heart is enfeebled, and temperature falls.

Respiration.—Small doses slightly accelerate, poisonous doses slow, respiration.

Nervous system.—Large doses are powerfully

depressant to the brain, to the medulla, and to the spinal cord, abolishing reflex action. Death occurs from paralysis of respiration.

Mucous membranes, kidneys, and skin.—Like other volatile oils, eucalyptus is excreted by all these channels. It imparts its odour to, and disinfects, the breath and the urine. It stimulates the organs by which it is excreted, consequently it is a diaphoretic, a stimulating expectorant, a diuretic, and a stimulant to the genito-urinary tract. Large doses cause renal congestion.

Therapeutics.

External.—It is used as an antiseptic for wounds, sores, and ulcers. It is three times as powerful as carbolic acid, and is therefore preferred by some surgeons. A eucalyptus gauze has been prepared as a dressing for wounds, which may be washed with a weak solution of the oil in alcohol. An ointment of eucalyptus oil 8 pts., iodoform 1 pt., hard paraffin and vaseline 40 pts. of each is applied to chancres. An emulsion of the oil is used as a urethral injection. It would probably be an efficient parasiticide.

Internal.—A vapour or a spray of oil of eucalyptus has been recommended for diphtheria and foul bronchitis, and it is sometimes given by the mouth to correct the fœtor of the expectoration. Occasionally it is used for its stomachic, carminative effects, especially if the fæces are very foul-smelling, and some employ it in cystitis and pyelitis. It has been prescribed in septicæmia. As an antiperiodic for ague and an antipyretic it is far inferior to quinine.

OIL OF ROSEMARY.

Oleum Rosmarini.—The oil distilled from the flowering tops of *Rosmarinus officinalis*.

Characters.—A colourless or pale yellow volatile oil. Odour of rosemary. Taste warm, aromatic. Sp. gr. 0·895 to 0·920.

Composition.—The chief constituents are—(1) The terpene, pinene. (2) Cineol. (3) Borneol, an alcohol isomeric with geraniol (p. 559). (4) Linalool (p. 551). (5) Menthol (p. 644).

Preparation.

Spiritus Rosmarini.—Oil of rosemary, 1; alcohol (90 per cent.), 9.

Oil of rosemary is contained in Linimentum Saponis and Tinctura Lavandulæ Composita.

Action and Therapeutics.

Oil of rosemary has an action similar to that of other aromatic volatile oils. It is very commonly used to give a pleasant scent to hair lotions and other preparations which are used externally.

ARNICA FLOWERS.

Arnicæ Flores.—The dried flower-heads of *Arnica montana.*

Characters.—Receptacle flat bristly with two rows of dark green hairy bracts. Each ray floret shrivelled, dark yellow corolla. Disc florets numerous, yellow. Fruits, slender, shrivelled.

Composition.—Contains a volatile oil.

Preparation.

Tinctura Arnicæ Florum.—1 in 10 of alcohol (40 per cent.). Percolate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Action and Therapeutics.

This tincture may be used externally as an application for bruises. Internally the tincture of the flowers is thought to be more active than one of the root, which was official in the Pharmacopœia of 1898, and is supposed to be useful in fevers, delirium tremens, and melancholia.

OIL OF LEMON GRASS.

Oleum Graminis Citrati. *Synonym.*—Indian oil of verbena. The oil distilled from *Cymbopogon citratus* and *Cymbopogon flexuosus*.

CHARACTERS.—A dark yellow oil, with an odour of verbena. Sp. gr. 0·88 to 0·905.

Dose, ½ to 3 m.—3 to 18 centimils.

ACTION AND THERAPEUTICS.

This oil is chiefly used in perfumery and to adulterate oil of verbena, which it closely resembles. Externally it is mixed with twice its bulk of any fixed oil as a rubefacient to relieve pain in myalgia and rheumatism. Internally it is carminative. It is used chiefly in India, the East and West Indies.

CLASS II. OF **Volatile Oils.**

Those used chiefly for their action on the gastro-intestinal tract.

PYRETHRUM.

Pyrethri Radix.—Pyrethrum. *Synonym.*—Pellitory root. The dried root of *Anacyclus pyrethrum*. Levant.

CHARACTERS.—Unbranched pieces, 5 to 10 centimetres long, 10 to 15 millimetres thick. Bark thick, brown, shrivelled; studded by dark-coloured receptacles for the resin. Close fracture, showing radiate surface. Inodorous. Causes a pricking sensation in the mouth when chewed. *Resembling pyrethrum.*—Taraxacum, which is darker, and has not a burning taste.

COMPOSITION.—The chief constituents are—(1) Volatile oils and resins. (2) Inulin.

Preparation.

Tinctura Pyrethri.—Powdered pyrethrum, 1; alcohol (70 per cent.), 5. Percolate.

ACTION AND THERAPEUTICS.

Pyrethrum is a powerful sialogogue, and causes a burning sensation in the mouth, followed by numbness and tingling. Small quantities give a pleasant taste to tooth powders.

CLOVES.

Caryophyllum.—Cloves. The dried flower-buds of *Eugenia caryophyllata*. Penang, Bencoolen, and Amboyna.

Characters.—About 15 millimetres long, consisting of a dark brown, wrinkled, subcylindrical, and somewhat angular calyx tube, which tapers below and is surmounted by four teeth, between which the paler-coloured petals, enclosing the numerous stamens and style, are rolled up in the form of a ball. Odour strong, fragrant, and spicy. Taste very pungent and aromatic. It emits oil when indented.

Composition.—The chief constituents are—(1) *Oleum Caryophylli*, 18 per cent. (*see below*). (2) Eugenin, a crystalline body. (3) Caryophyllin, a neutral body isomeric with camphor.

Preparation.

Infusum Caryophylli.—1 in 40 of boiling water.
Dose, ½ to 1 fl. oz.—15 to 30 mils.

Cloves are contained in Infusum Aurantii Compositum.

Oleum Caryophylli.—Oil of Cloves. The oil distilled from cloves.

Characters.—Colourless when recent, becoming yellowish and then brown. Taste and odour like cloves. Easily soluble in spirit or ether. Sp. gr. 1·047–1·065.

Composition.—The chief constituents are—(1) *Eugenol* (*synonym*, Eugenic acid), $C_{10}H_{12}O_2$, 85 per cent., which chemically resembles phenol, and forms permanent salts with alkalies. This is also found in oil of pimento. (2) A hydrocarbon, caryophyllene, $C_{15}H_{24}$.

Dose, ½ to 3 m.—3 to 18 centimils.

Oil of cloves is contained in Pilula Colocynthidis Composita, and Pilula Colocynthidis et Hyoscyami.

Incompatibles.—Lime water, salts of iron, mineral acids and gelatin.

Action of Cloves and Oil of Cloves.

Oil of cloves is a typical example of a volatile oil the most important actions of which are exerted in the stomach.

External.—When rubbed into the skin it is stimulant, rubefacient, irritant and counter-irritant,

and gives rise to considerable vascular dilatation. At first it causes a sensation of tingling and pain, which afterwards is replaced by local anæsthesia. It is a parasiticide and antiseptic.

Internal.—*Mouth.*—In the mouth, oil of cloves produces the same effects as on the skin; there is a burning sensation accompanied by vascular dilatation and an increased flow of saliva, and followed by local anæsthesia. Cloves stimulate the nerves of taste, and being volatile and aromatic, those of smell also; by both these means taste is sharpened.

Stomach.—The stimulant effect of cloves is experienced here. The vessels are dilated, excessive and irregular peristalsis is lessened, the secretion of gastric juice is excited, and as cloves are pleasant and aromatic, they do not ordinarily produce nausea; consequently the appetite is increased. The combined effect of these actions is to aid digestive processes—therefore oil of cloves is stomachic; and to facilitate the expulsion of gas—thus it is carminative. The stimulation of the gastric nerves to a slight extent reflexly affects the heart in the same way as alcohol; therefore the rate and force of the pulse are moderately increased.

Intestines.—Here likewise oil of cloves dilates the vessels, and stimulates the secretion and diminishes colicky pains due to irregular contraction of the muscular coat, and flatus is expelled.

Circulation.—Oil of cloves is readily absorbed from the intestine, circulates in the blood, and is said to increase the number of white corpuscles. It may to a slight extent stimulate the heart directly, but the greater part of the stimulation of the heart excited by it is reflex from the stomach. It is credited with the power of arresting painful spasmodic contractions in various parts of the body. It can, as we have seen, do this in the intestine, and possibly it may have to a slight extent the same action in the

bronchial tubes and heart. This causes it to be called **antispasmodic.**

Mucous membranes.—Like other volatile oils it is excreted by the kidneys, skin, bronchi, and genito-urinary tract, and in passing through these structures will act as a **stimulating disinfectant** to their secretion; but oil of cloves is never used for these purposes.

THERAPEUTICS OF CLOVES AND OIL OF CLOVES.

External.—Oil of cloves is too dear for frequent external application, but on account of its local anæsthetic effect it has been used for neuralgia. It is employed to give a pleasant scent to liniments.

Internal.—The oil is sometimes dropped into decayed teeth to relieve pain. Cloves are frequently employed in cookery for their taste, and because they stimulate the appetite and aid digestion. The oil or the infusion may be used medicinally as a stomachic, as a carminative, as an antispasmodic, or to relieve colicky pains in indigestion. It will have been noticed that oil of cloves is present in the two pills containing colocynth. This is to prevent the griping this purgative might otherwise cause.

BLACK PEPPER.

Black Pepper itself is not official but the confection is.

Preparation.

Confectio Piperis. *Synonym.*—Ward's paste. Black pepper, 2; caraway, 3; purified honey, 15.
Dose, 60 to 120 gr.—4 to 8 grms.

Black pepper is contained in Pulvis Opii Compositus.

ACTION.

Pepper, because of its volatile oil, acts like other substances containing volatile oils; thus externally

it is at first rubefacient and counter-irritant, and subsequently it acts as an anodyne. Internally it increases the secretions of the mouth, and in the stomach it is stomachic and carminative. During its excretion it stimulates the mucous membrane of the genito-urinary tract. Piperine, a constituent of pepper, is believed to be a feeble antipyretic and antiperiodic.

Therapeutics.

Occasionally pepper is used externally as an irritant for the same class of cases as mustard. Internally it may be employed, in the form of a gargle, as a stimulant for relaxed conditions of the throat. It is taken in the form of a condiment for its stomachic properties. The confection or pepper lozenges are given empirically to relieve hæmorrhoids, ulcers of the rectum, and fissures of the anus.

NUTMEG.

Myristica.—Nutmeg. The dried kernel of the seed of *Myristica fragrans.* Malay Archipelago.

Characters.—Ovoid, about 25 millimetres long. Externally greyish brown, with reticulated furrows. Internally greyish red, marbled with brownish-red veins. Odour aromatic. Taste warm, bitter, aromatic.

Composition.—The chief constituents are—(1) The fixed *concrete oil*, 25–30 per cent., which consists of Glyceryl oleate, Glyceryl butyrate, and Glyceryl myristate. (2) The official *volatile oil*, 2–8 per cent. (*see below*).

Nutmeg is contained in Pulvis Catechu Compositus, Pulvis Cretæ Aromaticus, Spiritus Armoraciæ Compositus, and Tinctura Lavandulæ Composita.

Oleum Myristicæ.—Volatile oil of nutmeg. The oil distilled from nutmegs.

Characters.—Colourless or pale yellow. Odour and taste of nutmeg. Sp. gr. 0·87 to 0·925.

Composition.—The chief constituents are — (1) The terpene, pinene. (2) Myristicin. (3) Myristic acid.

Dose, ½ to 3 m.—3 to 18 centimils.

Preparation.

Spiritus Myristicæ.—Oil of nutmeg, 1; alcohol (90 per cent.), 9.

Dose, 5 to 20 m.—3 to 12 decimils.

Oil of nutmeg is contained in Tinctura Guaiaci Ammoniata, Tinctura Valerianæ Ammoniata, and Spiritus Ammoniæ Aromaticus.

Spiritus Myristicæ is contained in Mistura Ferri Composita.

ACTION AND THERAPEUTICS.

The action of oil of nutmeg is the same as that of other aromatic oils. Nutmegs are much employed in cookery for the sake of their volatile oil, which is an agreeable stomachic. A Linimentum Myristicæ, containing one part of expressed oil of nutmeg to three of olive oil, is an elegant antiparasitic for mild cases of ringworm.

CINNAMON.

Cinnamomi Cortex.—The dried inner bark of shoots from the truncated stocks of the cultivated cinnamon tree, *Cinnamomum zeylanicum.* Ceylon.

CHARACTERS. — Closely rolled quills, 9 millimetres in diameter, and containing several smaller quills, thin, brittle, splintery. Externally dull light yellowish brown, with little scars and faint wavy lines. Internally darker brown. Odour fragrant. Taste warm, sweet, aromatic.

COMPOSITION.—The chief constituents are—(1) The official *volatile oil* (*see* p. 546) 0·2 to 1 per cent. (2) *Tannin.* (3) Sugar and gum.

IMPURITY.—Cassia bark.

Cinnamon is contained in Pulvis Catechu Compositus, Pulvis Cretæ Aromaticus, Pulvis Kino Compositus, Decoctum Hæmatoxyli, Tinctura Cardamomi Composita, and Tinctura Lavandulæ Composita.

Preparations.

1. Aqua Cinnamomi.—1 in 10.

Dose, 1 to 2 fl. oz.—30 to 60 mils.

2. **Pulvis Cinnamomi Compositus.**—Cinnamon, 1; cardamoms, 1; ginger, 1.
Dose, 10 to 60 gr.—6 to 40 decigrms.

3. **Tinctura Cinnamomi.**—Cinnamon, 1; alcohol (70 per cent.), 5. Percolate.
Dose, ½ to 1 fl. dr.—2 to 4 mils.

Aqua Cinnamomi is contained in Mistura Cretæ, Mistura Guaiaci, Mistura Olei Ricini, Syrupus Aromaticus, and Syrupus Cascaræ Aromaticus.

Compound cinnamon powder is contained in Pilula Aloës et Ferri and Pilula Cambogiæ Composita.

Oleum Cinnamomi.—The oil distilled from cinnamon bark.

CHARACTERS.—Yellowish, becoming cherry-red on keeping. Odour and taste like cinnamon. Sp. gr. 1·000 to 1·030.

COMPOSITION.—The chief constituents are—(1) Cinnamic aldehyde, which makes up the greater part. (2) A terpene. (3) Eugenol (*see* p. 541).
Dose, ½ to 3 m.—3 to 18 centimils.

Preparation.

Spiritus Cinnamomi.—Oil of Cinnamon, 1; alcohol (90 per cent.), 9.
Dose, 5 to 20 m.—3 to 12 decimils.

Spirit of cinnamon is contained in Acidum Sulphuricum Aromaticum.

ACTION AND THERAPEUTICS.

Oil of cinnamon has the same action as other aromatic volatile oils, and is therefore stomachic and carminative. Cinnamon bark in addition has, in virtue of its tannic acid, some astringent action, and is consequently a common flavouring stomachic vehicle for astringent powders and mixtures, except such as contain iron. Finely powdered cinnamon (60 to 90 gr., 4 to 6 grm.) is sometimes given morning and evening in acute dysentery.

OLIVER BARK.

Oliveri Cortex. *Synonym.*—Black Sassafras. The dried bark of *Cinnamomum oliveri.*

CHARACTERS.—Flat pieces 20 centimetres long and 4 centimetres wide. Covered with a grey brown warty cork. The inside of the bark is umber brown; odour and taste camphoraceous.

Preparation.

Tinctura Oliveri Corticis.—1 in 10 of alcohol (60 per cent.). Percolate.
Dose, ½ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTICS.

This bark may be employed for the same purposes as cinnamon, and some give it instead of sassafras. It is used chiefly in Australia.

HORSERADISH.

Armoraciæ Radix.—Horseradish Root. The fresh root of *Cochlearia armoracia.* Collected from cultivated plants.

CHARACTERS.—A long, cylindrical, fleshy root, enlarged at the upper end, where it is marked by scars of fallen leaves, 12 to 25 mm. in diameter, and usually 30 centimetres or more long. Pale yellowish or brownish white externally; whitish and fleshy within. Taste very pungent. Inodorous unless bruised or scraped, when it gives a pungent odour. *Resembling horseradish root.*—Aconite root, which is shorter, conical, not cylindrical, darker, and causes tingling and numbness when chewed.

COMPOSITION.—The chief constituent is a substance which, by the action of a ferment, yields a volatile oil, butyl sulphocyanide, C_4H_9CNS.

Preparation.

Spiritus Armoraciæ Compositus.—Scraped horseradish root, 125; dried bitter orange peel, 125; nutmeg, 3; alcohol (90 per cent.), 625; water, 750.
Dose, 1 to 2 fl. dr.—4 to 8 mils.

Action and Uses.

Horseradish is a condiment having the same action as mustard. It has been used as a counter-irritant. The spirit is a pleasant flavouring and carminative agent.

CAPSICUM.

Capsici Fructus. *Synonyms.*—Guinea pepper, Pod pepper. The dried ripe fruit of *Capsicum minimum*. Zanzibar.

Characters.—12 to 20 millimetres long, 6 millimetres in diameter, shrivelled, fusiform. Consists of a dull red, shining, smooth, brittle, translucent pericarp, enclosing several small, roundish, flat seeds. Odour peculiar, pungent. Taste very bitter.

Composition.—The chief constituents are—(1) Capsaicin, a crystallizable acid substance. (2) Capsicine, a volatile alkaloid smelling like coniine. (3) A volatile oil. (4) A resin. (5) Fatty matter.

Dried and powdered it constitutes red pepper.

Impurities.—Various red substances, *e.g.* red-lead.

Preparations.

1. Tinctura Capsici.—Capsicum, 1; alcohol (60 per cent.), 20. Macerate.

Dose, 5 to 15 m.—3 to 10 decimils.

2. Unguentum Capsici. — Capsicum, 25; hard paraffin, 10; soft paraffin, 75; prepared lard, 10.

In India prepared suet should be used instead of prepared lard.

The Tincture is contained in Tinctura Chloroformi et Morphinæ Composita.

Action.

The action of capsicum is like that of volatile oils generally. Thus externally it is a powerful rubefacient, irritant, and counter-irritant. Internally in small doses it stimulates the gastric secretions, causes dilatation of the gastric vessels, and excites the muscular coat. It is therefore stomachic and carminative.

THERAPEUTICS.

External.—Capsicum ointment is used as a counter-irritant for pleurisy, sciatica, neuralgia, and rheumatic pains. Capsicum plaster made with rubber is sold. The official tincture is too weak for external use, and the Tinctura Capsici Fortior (B. P. C.) is often too strong; and Martindale advises capsicum fruit 10, percolate with alcohol (90 per cent.) 70, add oleic acid 10 and oil of lavender $\frac{1}{2}$; paint on skin or apply sprinkled on lint covered with gutta percha; its action may be arrested by smearing with vaseline. Unguentum Oleoresinæ Capsici Co. (B. P. C.) is the same as the well-known Chillie paste and is an excellent counter-irritant. Equal parts of Tincture of Capsicum and Compound Linament of Camphor are painted on unbroken chilblains. Capsicum plasters containing no lead are applied to the gums for toothache. Wool impregnated with capsicum is applied in chronic rheumatism.

Internal.—It is used as a condiment. Medicinally it is given as a stomachic and carminative in dyspepsia when it is required to excite the appetite and digestion, or to cause the evacuation of gas.

GINGER.

Zingiber.—The scraped and dried rhizome of *Zingiber officinale.* East and West Indies.

CHARACTERS.—Flattish, irregularly branched pieces, usually 7 to 10 centimetres long, each branch marked at its summit by a depressed scar. Externally pale buff, striated, fibrous. Fracture mealy, short, rather fibrous. Odour agreeable, aromatic. Taste strong, pungent. *Resembling ginger.*—Turmeric, which is yellow.

COMPOSITION.—The chief constituents are—(1) An aromatic volatile oil, giving the flavour. (2) Gingerol. (3) Several resins and allied bodies.

Preparations.

1. Syrupus Zingiberis.—Powdered ginger, 25; alcohol (90 per cent.), q.s.; syrup, to 1000.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

2. Tinctura Zingiberis.—Ginger, 1; alcohol (90 per cent.), 10. Percolate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Ginger is contained in infusion of senna, compound squill pill, compound urginea pill, the compound powders of cinnamon, kaladana, jalap, opium, rhubarb, and scammony.

Tincture of ginger is contained in Acidum Sulphuricum Aromaticum.

Action and Therapeutics.

Its action is the same as that of other substances containing aromatic volatile oils. It is chiefly used as a stomachic, carminative, and flavouring agent. There is in commerce an oleo-resin, gingerin (Oleoresina Zingiberis, B. P. C.), which in doses of ¼ to 1 gr. (15 to 60 milligrms.) is a useful addition to purgative pills to prevent griping; and Tinctura Zingiberis Fortior (B. P. 1885), dose, 5 to 20 ♏ (3 to 12 decimils), commonly called essence of ginger, is much used for flatulence.

CARDAMOMS.

Cardamomi Semina.—Cardamom Seeds. The dried ripe seeds of *Elettaria cardamomum.* Malabar. The seeds should be kept in the pericarps, but when required for use they should be separated.

Characters.—The fruit is a three-sided capsule, 1 to 2 centimetres long, of a tough papery character, ovoid, obtusely triangular, shortly beaked, rounded at the base, pale buff, longitudinally striated; no odour or taste. Seeds 3 millimetres long, irregularly angular, transversely wrinkled, reddish brown externally, whitish within. Odour aromatic. Taste warm, aromatic.

Composition.—The chief constituents are—(1) A volatile oil, which contains a terpene called terpinene, $C_{10}H_{16}$. (2) A fixed oil. The pericarp is medically inactive.

Preparation.

Tinctura Cardamomi Composita.—Cardamoms, 14; caraway, 14; cinnamon, 28; cochineal, 7;

glycerin, 100 alcohol (45 per cent.), to make 1000. Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Compound tincture of cardamoms is contained in Decoctum Aloes Compositum, and Mistura Sennæ Composita.

Cardamoms are contained in Extractum Colocynthidis Compositum, Pulvis Cinnamomi Compositus, Pulvis Cretæ Aromaticus, Tinctura Gentianæ Composita, and Tinctura Rhei Composita.

Action and Therapeutics.

Cardamom seeds, because of their volatile oil, act like cloves or pepper; therefore they are carminative and stomachic. As they have a pleasant taste, and the compound tincture is of a red colour, it is much used as a colouring and flavouring agent. This tincture is a good flavouring carminative and the Tinctura Carminativa (B. P. C. dose, 2 to 10 ♏—1 to 6 decimils) is another. It contains cardamoms, strong tincture of ginger, oil of cinnamon, oil of caraway, oil of cloves and rectified spirit.

OIL OF LAVENDER.

Oleum Lavandulæ.—The oil distilled from the flowers of *Lavandula vera*.

Characters.—A colourless or pale yellow volatile oil. Odour of lavender. Taste warm, bitter. Sp. gr. 0·883 to 0·9.

Impurity.—Oil of spike.

Composition.—The chief constituents are—(1) Linalool acetate (also found in oil of bergamot). (2) Linalool, $C_{10}H_{17}OH$, which is an alcohol and an oxidation product of the terpene myrcene $C_{10}H_{16}$. It is isomeric with borneol (p. 539), geraniol (p. 559), and menthol (p. 644). (3) Cineol, also found in oil of eucalyptus (*see* p. 537) and other volatile oils.

Dose, ½ to 3 m.—3 to 18 centimils.

Preparations.

1. **Spiritus Lavandulæ.**—Oil of lavender, 1; alcohol (90 per cent.), 9.

Dose, 5 to 20 m.—3 to 12 decimils.

2. Tinctura Lavandulæ Composita.—Oil of lavender, 5; oil of rosemary, 0·5; cinnamon, 10; nutmeg, 10; red sanders-wood, 20; alcohol (90 per cent.), to produce 1000. Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Oil of lavender is contained in Linimentum Camphoræ Ammoniatum.

Compound tincture of lavender is contained in Liquor Arsenicalis.

Action and Therapeutics.

Oil of lavender has the same action as other aromatic volatile oils. It is used externally as a pleasant stimulating component of liniments, and most red lotions (*see* p. 181) are coloured with the compound tincture. Internally, especially in the form of the tincture, it makes a very agreeable gastric stimulant, carminative, and colouring agent.

OIL OF PEPPERMINT.

Oleum Menthæ Piperitæ.—The oil distilled from the fresh flowering peppermint, *Mentha piperita.*

Characters.—Colourless, pale, or greenish yellow, thickening and becoming reddish with age. Odour like that of peppermint. Taste aromatic, followed by a sense of coldness. Sp. gr. 0·9 to 0·92.

Composition.—The chief constituents are—(1) *Menthol*, or mint camphor, $C_{10}H_{19}{\cdot}OH$, 50 to 65 per cent. (*see* p. 644). (2) Menthene, $C_{10}H_{18}$, a liquid terpene. (3) Menthyl acetate.

Dose, ½ to 3 m.—3 to 18 centimils.

Preparations.

1. Aqua Menthæ Piperitæ.—1 in 1000.

Dose, 1 to 2 fl. oz.—30 to 60 mils.

2. Spiritus Menthæ Piperitæ.—Oil of peppermint, 1; alcohol (90 per cent.), 9.

Dose, 5 to 20 m.—3 to 12 decimils.

Oil of peppermint is contained in Pilula Rhei Composita and Tinctura Chloroformi et Morphinæ Composita.

ACTION AND THERAPEUTICS.

The action of oil of peppermint is the same as that of volatile oils generally, but the cool numb-feeling often produced by volatile oils after the sensation of warmth has passed off is especially well marked with oil of peppermint, and this effect, which is due to the menthol in it, has caused it to be applied externally in neuralgia. Like many other volatile oils it is a powerful antiseptic.

Internally it is a powerful stomachic and carminative, is often used as such, and also as a flavouring agent.

OIL OF SPEARMINT.

Oleum Menthæ Viridis.—The volatile oil distilled from the fresh flowering spearmint, *Mentha viridis* or *Mentha crispa*.

CHARACTERS.—Very like oil of peppermint.

COMPOSITION.—The chief constituents are—(1) *Menthene*, the same terpene as in peppermint. (2) *Carvone* or *Carvol*, $C_{10}H_{14}O$; also found in oil of caraway (*see* p. 556).

Dose, ½ to 3 m.—3 to 18 centimils.

Preparation.

Aqua Menthæ Viridis.—1 in 1000.
Dose, 1 to 2 fl. oz.—30 to 60 mils.

ACTION AND THERAPEUTICS.

These are the same as those of oil of peppermint.

ANISE.

Anisi Fructus.—Anise Fruit. The dried ripe fruit of *Pimpinella anisum*.

CHARACTERS.—Anise fruits are about 5 mm. in length, oval-oblong, greyish-brown in colour, and the whole surface is covered with short hairs. The two mericarps are united and attached to a common stalk; each is traversed by five pale

slender ridges, and its transverse section exhibits about fifteen vittæ. Odour agreeable, aromatic. Taste sweetish, spicy.

COMPOSITION.—The chief constituent is the official *volatile oil* (*see below*).

Preparation.

Aqua Anisi.—1 in 10.
Dose, 1 to 2 fl. oz.—30 to 60 mils—or more.

Oleum Anisi.—The volatile oil, distilled from the anise fruit (*see* p. 553), or from the star-anise fruit (*Illicium verum*).

CHARACTERS.—Colourless or very pale yellow, with the odour of the fruit, and an aromatic, sweetish taste. Sp. gr. 0·975 to 0·99.

COMPOSITION.—The chief constituents are—(1) Anethol, 85 per cent., $C_{10}H_{12}O$. (2) Anisic aldehyde. (3) Methyl-chavicol.

Dose, $\frac{1}{2}$ to 3 m.—3 to 18 centimils.

Preparation.

Spiritus Anisi.—Oil of anise, 1; alcohol (90 per cent.), 9.
Dose, 5 to 20 m.—3 to 12 decimils.

Oil of anise is contained in Tinctura Camphoræ Composita, and Tinctura Opii Ammoniata.

ACTION AND THERAPEUTICS.

The action of oil of anise is the same as that of aromatic oils generally. It is specially used to get rid of flatulence in children, and, on account of its slightly expectorant action, as a basis of cough mixtures.

CORIANDER FRUIT.

Coriandri Fructus.—The dried ripe fruit of *Coriandrum sativum.*

CHARACTERS.—Nearly globular, 5 millimetres in diameter, and consisting of two closely united hemispherical mericarps, crowned by the calyx teeth and stylopod, brownish yellow, hard, faintly ribbed with both primary and secondary ridges. The mericarps each enclose a lenticular cavity, and each is

furnished on its commissural surface with two brown vittæ. Taste agreeable, mild, aromatic. Odour pleasant when bruised.

COMPOSITION.—The chief constituent is the official *volatile oil* (*see below*).

Coriander fruit is contained in Confectio Sennæ, Syrupus Rhei, Tinctura Rhei Composita, Tinctura Sennæ Composita.

Oleum Coriandri.—A volatile oil distilled from the fruit.

CHARACTERS.—Colourless or pale yellow, with the odour and taste of the fruit. Sp. gr. 0·87 to 0·885.

COMPOSITION.—The chief constituents are—(1) Coriandrol, isomeric with linalool (*see* p. 551). (2) Pinene, the chief terpene of oil of turpentine, 5 per cent.

Dose, ½ to 3 m.—3 to 18 centimils.

Oil of coriander is contained in Syrupus Sennæ.

ACTION AND THERAPEUTICS.

Oil of coriander has the same action as other volatile oils. It is chiefly used as a stomachic and carminative, and to disguise the taste of rhubarb and senna.

FENNEL FRUIT.

Fœniculi Fructus.—The dried ripe fruit of cultivated plants of *Fœniculum vulgare*. Malta.

CHARACTERS.—Small ovoid-oblong, straight or curved, smooth, greenish brown or brown, capped by a conspicuous stylopod and two styles. Odour aromatic. Taste aromatic, sweet. Fruit readily separated into its two mericarps, each of which has five prominent primary ridges, and exhibits in transverse section six large vittæ. *Resembling fennel.*—Conium fruit (fennel is larger and has prominent vittæ), caraway, and anise fruits.

COMPOSITION.—The chief constituent is a volatile oil probably identical with oil of anise.

Preparation.

Aqua Fœniculi.—1 in 10.
Dose, 1 to 2 fl. oz.—30 to 60 mils.

Fennel fruit is contained in Pulvis Glycyrrhizæ Compositus.

Action and Therapeutics.

The same as those of oil of anise or of coriander fruit.

CARAWAY FRUIT.

Carui Fructus.—Caraway Fruit. The dried ripe fruit of *Carum carvi*.

Characters.—The fruit is usually separated into its two mericarps, each about 4 to 6 millimetres long, slightly curved, tapering at each end, brown, with five pale longitudinal ridges; the transverse section of each mericarp exhibits six vittæ. Odour agreeable, aromatic. Taste pleasant, sweetish, spicy. *Resembling caraway.*—Conium and fennel. Known by the small ridges and the spicy taste of caraway.

Composition.—The chief constituent is the volatile oil (*see below*).

Preparation.

Aqua Carui.—1 in 10.
Dose, 1 to 2 fl. oz.—30 to 60 mils.

Caraway fruit is contained in Pulvis Opii Compositus, Confectio Piperis, Tinctura Cardamomi Composita, Tinctura Sennæ Composita.

Oleum Carui.—The oil distilled from caraway fruit and rectified.

Characters.—Colourless or pale yellow, with odour and taste like the fruit. Sp. gr. 0·91 to 0·92.

Composition.—The chief constituents are—(1) Cymene, $CH_3C_6H_4 \cdot CH(CH_3)_2$; also found in eucalyptus oil. (2) Carvone, $C_{15}H_{24}$; this is the essential constituent. (3) Dextrorotatory carvone or carvol, $C_{10}H_{14}O$, isomeric with thymol (*see* p. 643); also found in oil of spearmint (p. 553). (4) Limonene, a terpene, $C_{10}H_{16}$; also found in oil of lemon (*see* p. 646).

Dose, ½ to 3 m.—3 to 18 centimils.

Oil of caraway is contained in Pilula Aloes.

Action and Therapeutics.

The action and uses of oleum carui are the same as those of other aromatic volatile oils. It is employed as a carminative, stomachic, and flavouring agent.

DILL FRUIT.

Anethi Fructus.—The dried ripe fruit of *Peucedanum graveolens.*

Characters.—Broadly oval, 4 mm. long, brown, flat, with a pale, broad, membranous border. Mericarps distinct, each shows six vittæ. Odour and taste agreeable and aromatic. *Resembling dill.*—Conium, anise, fennel, caraway; but dill is winged.

Composition.—The chief constituent is the official *volatile oil* (*see below*).

Preparation.

Aqua Anethi.—1 in 10.
Dose, 1 to 2 fl. oz.—30 to 60 mils.

Oleum Anethi.—The oil distilled from the dill fruit.

Characters.—Pale yellow. Odour pungent. Taste hot and sweetish. Sp. gr. 0·900 to 0·915.

Composition.—The chief constituents are almost identical with those of caraway oil (*see* p. 556).

Dose, ½ to 3 m.—3 to 18 centimils.

Action and Therapeutics.

The same as those of anise and caraway. Dill water is a common carminative for children, and it covers very well the taste of sodium salts.

CHAMOMILE.

Anthemidis Flores.—Chamomile Flowers. The dried expanded flower heads of *Anthemis nobilis.* Collected from cultivated plants.

Characters.—About 12 to 20 mm. in diameter, hemispherical, white or nearly white. Involucre composed of several rows of oblong bracts with membranous margins. Receptacle solid, covered with bracts. Florets ligulate and white. Odour aromatic. Taste bitter.

Composition.—The chief constituent is the official *volatile oil.*

Oleum Anthemidis.—The volatile oil distilled from chamomile flowers.

CHARACTERS.—Pale blue or greenish blue, becoming yellowish brown. Odour and taste like chamomile. Sp. gr. 0·905 to 0·915.

COMPOSITION.—The chief constituents are—(1) A terpene, $C_{10}H_{16}$. (2) Angelic and tiglic esters of isobutyl, amyl, and hexyl alcohols. (3) A bitter principle.

Dose, ½ to 3 m.—3 to 18 centimils.

ACTION AND THERAPEUTICS.

A poultice made with chamomile flowers was a popular domestic remedy. All its virtues are due to its warmth. Internally, like other volatile oils, oil of chamomile is a stomachic and carminative. An infusion is in large doses a simple emetic.

ROSE PETALS.

Rosæ Gallicæ Petala.—Red Rose Petals. The fresh or dried unexpanded petals of *Rosa gallica*. From cultivated plants. Britain.

CHARACTERS.—Little cone-shaped masses or separate petals; *purplish red, velvety. Odour fragrant*, roseate. Taste bitterish, feebly acid, and astringent.

COMPOSITION.—The chief constituents are—(1) *Oleum Rosæ*, a volatile oil present in minute quantities (*see below*). (2) Tannic and gallic acids.

Preparations.

1. **Confectio Rosæ Gallicæ.**—*Fresh* petals, 1 sugar, 3.

2. **Infusum Rosæ Acidum.**—*Dried* petals, 1; dilute sulphuric acid, ½; boiling water, 40. The sulphuric acid makes it a darker red than it would otherwise be.

   Dose, ½ to 1 fl. oz.—15 to 30 mils.

3. **Syrupus Rosæ.**—*Dried* petals, 1; sugar, q.s.; boiling water, 10.

   Dose, ½ to 1 fl. dr.—2 to 4 mils.

OIL OF ROSE.

Oleum Rosæ. *Synonym.*—Otto of Rose. The oil distilled from the fresh flowers of *Rosa damascena*.

CHARACTERS AND TESTS.—At ordinary temperatures a pale yellow crystalline semi-solid, melting between 20° and 23°C.,

to a pale yellow oil with a strong rose odour and taste. Sp. gr. 0·854 to 0·862.

COMPOSITION.—The chief ingredient is geraniol or rhodinol, a fragrant liquid. It is an alcohol and is related to linalool, which occurs in oil of lavender (p. 551).

Preparations.

1. Aqua Rosæ.—Rose water. The rose water of commerce, prepared by distillation from the flowers of *Rosa damascena.* It is a saturated solution of oleum rosæ, and is diluted immediately before use with twice its volume of distilled water.

Dose, 1 to 2 fl. oz.—30 to 60 mils.

2. Unguentum Aquæ Rosæ.—Rose water, 20; white beeswax, 18; purified borax, 1; almond oil, 61; oil of rose, 0·1. *Synonym.*—Cold Cream.

Rose water is contained in Mistura Ferri Composita and certain lozenges.

ACTION AND THERAPEUTICS.

The preparations of rose are pleasant vehicles, the confection for pills, the infusion, which is mildly astringent, for mixtures, the aqua for lotions, and the ointment for ointments. The syrup and the acid infusion are agreeable colouring agents.

BETEL.

Betel.—The dried leaves of *Piper betel.*

CHARACTERS.—Broadly ovate, acuminate, obliquely cordate at base, glossy on upper surface. In commerce often tied or stitched in packets, about 15 centimetres long.

ACTION AND THERAPEUTICS.

Throughout the whole of India all classes of natives indulge in the habit of chewing betel leaves. White catechu and areca nut or betel nut, mixed with various spices and aromatics, are wrapped up in betel leaves which have been previously smeared with a little chunam or shell lime, and little masses of this mixture are chewed. This habit largely increases

the amount of saliva. Betel leaves contain an aromatic oil. Warm and smeared with oil they are applied to the chest in bronchitis and pleurisy and to the breasts to retard the secretion of milk.

CLASS III. OF Volatile Oils.

Those used chiefly for their actions on the heart and central nervous system.

VALERIAN.

Valerianæ Rhizoma.—Valerian Rhizome. The dried rhizome and roots of *Valeriana officinalis*. Collected in the autumn.

CHARACTERS.—Short, erect rhizome, entire or sliced. Externally dark yellowish brown, giving off many slender, brittle, shrivelled rootlets, 7 to 10 centimetres long. Internally whitish. Odour developed in drying, strong, peculiar, disagreeable. Taste unpleasant, camphoraceous, bitter. *Resembling valerian.*—Serpentary, arnica, green hellebore; but valerian is known by its odour.

COMPOSITION.—The chief constituents are—(1) *A volatile oil* containing valerianic, formic, and acetic acids united with pinene, a terpene (*see* p. 525), and borneol (*see* p. 640). If the oil is kept it decomposes slightly and *valerianic acid*, $HC_5H_9O_2$, is set free. This exists in many plants, and in cod-liver oil. The amount of it in valerian increases by keeping. It can be derived from amylic alcohol, $C_5H_{11}OH$ (valeryl aldehyde). It is colourless, oily, with the odour of valerian, and strongly acid, with a burning taste. *Solubility.*—1 in 30 of water; easily in alcohol and ether.

Preparation.

Tinctura Valerianæ Ammoniata.—Powdered valerian, 200; oil of nutmeg, 3; oil of lemon, 2; solution of ammonia, 100; alcohol (90 per cent.), 900. Macerate. **Dose, ½ to 1 fl. dr.—2 to 4 mils.**

Zinci Valerianas.—Zinc Valerianate. $Zn(C_5H_9O_2)_2$, $2H_2O$.

SOURCE.—Obtained by saturating iso-valerianic acid with zinc carbonate, or by the interaction of zinc sulphate and sodium iso-valerianate.

Characters.—Pearly scales with a feeble odour of valerian and a metallic taste. *Solubility.*—1 in 120 of water.

Incompatibles.—All acids, soluble carbonates, most metallic salts, vegetable astringents.

Dose, 1 to 3 grs.—6 to 20 centigrms.

Action.

Neither valerianic acid nor zinc valerianate is known to have any action.

Valerian itself acts in virtue of its volatile oil, which has the same properties as other volatile oils. Valerian is therefore an irritant when applied externally; internally it stimulates the mouth, stomach, and intestines; consequently it increases the appetite and the vascularity and the secretion, and regulates the peristaltic action of the stomach and intestines; and in its excretion, which takes place chiefly through the bronchial mucous membrane, kidneys, and genito-urinary mucous membrane, it excites the flow of fluids excreted through these parts. Acting reflexly from the stomach, it stimulates the circulation rather more powerfully than most volatile oils.

Therapeutics.

Preparations of valerian, or still better the oil (2 to 5 ♏, 12 to 30 centimils) suspended in mucilage with cinnamon water, are often given as carminatives in cases of flatulence, and as reflex stimulants in fainting or palpitation. Valerian and valerianates sometimes relieve neuralgia; they are often prescribed for hysteria and other neurotic conditions, and sometimes with benefit. The Pilulæ Ferri Valerianatis Co. (B. P. C.) commonly called the Pill of Three Valerianates, containing a grain of Iron Valerianate, Quinine Valerianate, and Zinc Valerianate (dose 1 to 2 pills) is excellent for anæmic, neurotic women.

INDIAN VALERIAN.

Valerianæ Indicæ Rhizoma.—The dried rhizome and rootlets of *Valeriana wallichii.*

CHARACTERS.—The rhizome is curved, about 5 centimetres long, 5 to 10 millimetres diameter; dull brown; marked with transverse ridges; thickly studded with circular prominent tubercles to which a few thick rootlets are attached. The crown has a number of bracts; the lower end is blunt. The smell is characteristic.

Preparation.

Tinctura Valerianæ Indicæ Ammoniata.—Indian valerian, 200; oil of nutmeg, 3; oil of lemon, 2; solution of ammonia, 100; alcohol (60 per cent.), 900. Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTICS.

The action and uses of Indian valerian are precisely the same as those of ordinary valerian. It is used chiefly in India and the East.

ASAFETIDA.

Asafetida.—An oleo-gum-resin obtained by incision into the root of *Ferula fetida*, and probably other species of *Ferula.* Afghanistan and the Punjaub.

CHARACTERS.—Usually in irregular masses, composed of dull yellow tears agglutinated together by darker coloured, softer material. When broken or cut, the exposed surface has an amygdaloid appearance; the fractured surface is opaque, milk-white at first, but becomes first purplish pink and finally dull yellowish brown. Odour strong, alliaceous, persistent. Taste bitter, acrid, alliaceous. Asafetida forms a white emulsion with water. The fractured surface of a tear, on being touched with sulphuric acid, becomes a fine red. *Resembling asafetida.*—Galbanum, ammoniacum, and benzoin, distinguished by their peculiar odours, which differ markedly from that of asafetida.

COMPOSITION.—The chief constituents are—(1) *A volatile*

oil, 5 per cent., containing essential oil of garlic, persulphide of allyl, $(C_3H_5)_2S$. This gives asafetida its very unpleasant odour. (2) Bassorin resin, 65 per cent. (3) Gum, 25 per cent.

IMPURITIES.—Earthy matter.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Preparations.

1. Pilula Aloes et Asafetidæ.—Asafetida, Socotrine aloes, hard soap, and confection of roses, equal parts with syrup of glucose.

Dose, 4 to 8 gr.—25 to 50 centigrms.

2. Spiritus Ammoniæ Fetidus.—Asafetida, 75; strong solution of ammonia, 100; alcohol (90 per cent.), 1000.

Dose, 20 to 40 m.—12 to 25 decimils—for repeated, **60 to 90 m.—4 to 6 mils**—for single administration largely diluted.

3. Tinctura Asafetidæ.—Asafetida, 2; alcohol (70 per cent.), 10. Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils. The resin precipitates on the addition of water, but may be re-*dissolved in ammonia or suspended in mucilage.*

ACTION.

Both internally and externally, asafetida, in virtue of its volatile oil, acts like volatile oils generally. Its action as a regulator of the intestinal muscle is especially well marked, hence it is combined with aloes in Pilula Aloes et Asafetidæ; and the enema of it will relieve flatus. Owing to its containing oil of garlic it is extremely nasty, and therefore it is not, like many volatile oils, available as a condiment. Its taste is credited with some mental effect in cases of hysteria.

THERAPEUTICS.

Asafetida is not used externally. Internally it is prescribed to aid the action of other purgatives, and also to stimulate the muscular coat to expel flatus. It may be given by the mouth or as an enema (30 gr., 2 grms., rubbed up with water 4 fl. oz., 120 mils).

Partly on account of its reflex stimulating effect, but also on account of its very nasty taste, it is used to control hysterical, emotional, and other mental disturbances, but it often fails. For this purpose it may be combined with valerian. Cases of malingering may sometimes be cured by making the patient take, three times a day, an effervescing draught containing a few minims of each of the tinctures of valerian and asafetida, with some mucilage to suspend the precipitated resin. The effervescence makes the nasty taste of these medicines "repeat" in the mouth for some time after taking them. Hysteria may be benefited in the same way. Asafetida oil would in the course of its excretion disinfect the urine and the expectoration, but its smell forbids its use for these purposes.

AMMONIACUM.

Ammoniacum.—A gum-resin exuded from the flowering and fruiting stem of *Dorema ammoniacum* and possibly other species. Persia and the Punjaub.

Characters.—Small roundish tears, or masses of agglutinated tears; pale brown externally, milky white and opaque internally. Hard and brittle when cold, with a dull waxy fracture, but softening with heat. Odour faint, peculiar, non-alliaceous. Taste bitter, acrid. Forms a nearly white emulsion with water. *Resembling ammoniacum.*—Asafetida, galbanum, benzoin, known by odour.

Composition.—The chief ingredients are—(1) Volatile oil, 4 per cent. (2) Resin, 70 per cent. (3) Gum, 20 per cent.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Preparation.

Mistura Ammoniaci.—Ammoniacum, 3, added gradually during trituration to 100 of water and 6 of syrup of tolu. It forms a milk-like emulsion.

Dose, $\frac{1}{2}$ to 1 fl. oz.—15 to 30 mils.

Ammoniacum is contained in Pilula Ipecacuanhæ cum Scilla, Pilula Scillæ Composita, Pilula Ipecacuanhæ cum Urginea, and Pilula Urgineæ Composita.

Action and Therapeutics.

The actions of ammoniacum are precisely the same as those of volatile oils generally. It has been employed externally to aid, by its mildly irritating effects, the absorption of chronic inflammatory products, and internally in chronic bronchitis with offensive expectoration for the sake of the remote disinfectant expectorant effect that it has in the course of its excretion through the bronchial mucous membrane.

MYRRH.

Myrrha.—An oleo-gum-resin obtained from the stem of *Commiphora Myrrha* and probably other species. Arabia and Somaliland.

Characters.—Roundish or irregularly formed tears or masses of agglutinated tears, varying very much in size. Externally reddish brown or reddish yellow; dry, covered with a fine powder; brittle. The fractured surface is irregular, brown, somewhat translucent, and oily. Odour agreeable, aromatic. Taste aromatic, acrid, bitter. Insoluble in water; when rubbed up with it, forms an emulsion.

Composition.—The chief constituents are—(1) *Myrrhin*, a resin, 23 per cent. (2) *Myrrhol*, $C_{10}H_{14}O$, a volatile oil, 2 per cent. (3) Gum, 60 per cent. (4) A bitter principle.

Impurities.—Many varieties of gum and gum-resins.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Preparations.

1. **Tinctura Myrrhæ.**—Myrrh, 1; alcohol (90 per cent.), 5. Macerate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

2. **Pilula Aloes et Myrrhæ** (*see* Aloes).

Myrrh is contained in Decoctum Aloes Compositum, Mistura Ferri Composita, and Pilula Rhei Composita.

Action.

External.—Both externally and internally myrrh has the same actions as other substances containing

a volatile oil. It is a mild disinfectant, and a stimulant to sores and ulcers.

Internal.—It has the same effects in the mouth. It is a **stomachic carminative**, exciting the appetite, the flow of gastric juice, and the vascularity and peristalsis of the stomach and intestines. The number of leucocytes in the blood is said to be increased by the administration of myrrh. It is excreted by *mucous membranes, especially* the genito-urinary and the bronchial, and it stimulates and disinfects their secretions in its passage through them. Thus it becomes an expectorant, a uterine stimulant, and an emmenagogue.

Therapeutics.

External.—Occasionally myrrh has been employed as a stimulant to sores and ulcers.

Internal.—It is, in the form of $\frac{1}{2}$ fl. dr. (2 mils) of the tincture diffused through 1 fl. oz (30 mils) of water, used as a mouth wash and gargle for sore spongy gums, relaxed throat, and other similar conditions, for which it is often combined with borax, as in the following formula:—Myrrh, 1; eau de Cologne, 16; borax, 1; water, 3; syrup, 3. It is frequently given with purgatives for the sake of its carminative and stomachic properties. It is also commonly combined with iron when this drug is given for anæmia, but the reason for this is not clear. It is prescribed for amenorrhœa, and has been given for cystitis, and as a disinfectant expectorant for chronic bronchitis.

Class IV. of **Volatile Oils.**

Those used chiefly for their action on the bronchial mucous membrane.

TEREBENE.

Terebenum.—Terebene. A mixture of dipentene and other hydrocarbons.

SOURCE.—Produced by agitating oil of turpentine with successive portions of sulphuric acid until it no longer rotates the plane of a ray of polarized light, and then distilling in a current of steam.

CHARACTERS.—Colourless liquid, with a pleasant pine-wood odour. It does not mix with water, but can easily be emulsified with tragacanth, or it may be taken on sugar or in capsules. Sp. gr. 0·862 to 0·866.

Dose, 5 to 15 m.—3 to 10 decimils.

ACTION AND THERAPEUTICS.

Terebene is an excellent stimulating disinfectant expectorant for chronic bronchitis. It may be used as an inhalation thus: Terebene, 45 ♏ (3 mils); light carbonate of magnesium, 20 gr. (12 decigrms); distilled water, 1 fl. oz. (30 mils). Use a fluid drachm of this mixture in a pint of water at 50° C. in an apparatus so arranged that air can be drawn through it and inhaled. It may be given as an expectorant either in capsules, lozenges, or suspended in a mixture; many patients find five drops a few times a day on sugar quite sufficient to cure a slight winter cough. Terpin hydrate commonly called Terpine, a white solid, may be given in doses of 3 to 10 gr.—2 to 6 decigrms.—in a cachet, or suspended as an expectorant. It is made into an elixir with diamorphine hydrochloride (*see* p. 381).

BALSAM OF PERU.

Balsamum Peruvianum.—A balsam exuded from the trunk of *Myroxylon pereiræ*, after the bark has been beaten and scorched. Salvador in Central America.

CHARACTERS.—A liquid about as viscid as treacle, nearly black in bulk; in thin layers orange or reddish brown, and transparent. Odour balsamic. Taste disagreeable, burning. *Solubility.*—Insoluble in water, easily in chloroform, and in 1 of alcohol (90 per cent.), but on the addition of more alcohol the mixture becomes turbid.

COMPOSITION.—The chief constituents are—(1) A volatile oil. This is present in large quantities; it consists of cinnamin

(cinnamate of benzyl), styracin (cinnamate of cinnamyl), $C_8H_7COOC_9H_9$, peruvin (benzyl alcohol), styrone (cinnamic alcohol), and benzoate of benzyl. (2) Cinnamic acid, $C_6H_5 \cdot CH \cdot CH \cdot COOH$ (*see* p. 569). (3) Benzoic acid (*see* p. 648). (4) Resins.

Dose, 5 to 15 m.—3 to 10 decimils—made into an emulsion with mucilage or yolk of egg.

Action and Therapeutics.

External.—Like most substances containing a volatile oil, balsam of Peru is a disinfectant, and also a stimulant when rubbed into the skin or applied to raw surfaces. Formerly it was much used for these purposes, chiefly as an application to indolent sores and chronic eczema. A mixture of balsam of Peru 1 part, lard 7 parts, is very useful for sore nipples and cracked lips, but now it is not often employed externally except as an antiparasitic for pediculi, scabies, and ringworm. For scabies it should be applied in the way already described for sulphur ointment; it is a more agreeable preparation.

Internal.—Like most volatile oils balsam of Peru is carminative and stomachic, and after absorption is excreted by, and stimulates and disinfects the mucous membranes. For this reason it is used as an expectorant in chronic bronchitis. It is also excreted by the skin and the kidneys.

BALSAM OF TOLU.

Balsamum Tolutanum.—A balsam which on incision exudes from the trunk of *Myroxylon toluiferum*. New Granada.

Characters.—A reddish-yellow, soft, tenacious solid, becoming hard by keeping and brittle in the cold. A lens shows microscopic crystals of cinnamic acid. Very fragrant odour. Taste aromatic. *Solubility.*—Easily in alcohol (90 per cent.), not in water.

Composition.—The chief constituents are—(1) Toluene, C_7H_8. (2) Benzoic acid (*see* p. 648). (3) Cinnamic acid

(*see below*). (4) Tolu-resinotannol. (5) Benzyl benzoate. (6) Benzyl cinnamate. (7) Vanillin.

Dose, 5 to 15 gr.—3 to 10 decigrms.—as an emulsion with mucilage or yolk of egg.

Preparations.

1. Syrupus Tolutanus.—Balsam of Tolu, 25; sugar, 660; water to make 1000 (contains very little balsam of tolu, as that is almost insoluble in syrup).

Dose, ½ to 1 fl. dr.—2 to 4 mils.

2. Tinctura Tolutana.—Balsam of Tolu, 1; alcohol (90 per cent.), 10. Dissolve.

Dose, ½ to 1 fl. dr.—2 to 4 mils. The balsam of tolu is precipitated by adding water, therefore it should be suspended with mucilage.

Balsam of Tolu is contained in Tinctura Benzoini Composita.

Tincture of Tolu is contained in Trochisci Acidi Carbolici Morphinæ, and Morphinæ et Ipecacuanhæ.

Syrup of Tolu is contained in Mistura Ammoniaci.

Action and Therapeutics.

Although it has an action in all respects similar to that of balsam of Peru, it is only used as an expectorant in cough mixtures.

STORAX.

Styrax Præparatus.—Prepared Storax. A viscid balsam obtained from the wounded trunk of *Liquidambar orientalis* purified by solution in alcohol, filtration, and evaporation of the solvent. Asia Minor.

Characters.—A brownish-yellow, semi-transparent, semi-fluid balsam. Odour strong, agreeable. Taste balsamic.

Composition.—The chief constituents are—(1) Styrene, $C_6H_5{\cdot}CH{\cdot}CH_2$, a derivative of cinnamic acid. (2) Cinnamic acid, $C_6H_5{\cdot}CH{\cdot}CH{\cdot}COOH$, colourless, odourless, crystalline, can be oxidized to benzoic acid, is also found in balsams of Tolu and Peru. (3) Styracin, which is cinnamate of cinnamyl, $C_8H_7COOC_9H_9$. (4) Two resins.

Storax is contained in Tinctura Benzoini Composita.

Action and Therapeutics.

Storax has just the same action as balsams of Tolu and Peru and benzoin, and may be employed for the same purposes. It is not often given internally except in the compound tincture of benzoin. Mixed with an equal part of olive oil it may be used to kill the *Sarcoptes hominis* and pediculi.

Cinnamic acid greatly increases the leucocytes in the blood and the uric acid in the urine. Sodium cinnamate dissolved either in water or glycerin has been given subcutaneously or intravenously to stimulate leucocytosis in cases of tuberculous disease, and coumaric acid (a derivative of cinnamic acid) has been used for phthisis and cancer, but neither has found much favour.

OIL OF SIBERIAN FIR.

Oleum Abietis.—*Synonym.*—Oil of Pine. The oil distilled from the fresh leaves of *Abies sibirica.* Russia. Pinol and Pumiline are similar proprietary preparations.

This was called Oleum Pini, B. P. 1898.

Characters.—Almost colourless. Odour aromatic. Taste pungent. Sp. gr. 0·90 to 0·92.

Composition.—(1) Various terpenes. (2) Bornyl acetate.

Action and Therapeutics.

The action of oil of Siberian Fir is the same as that of oil of turpentine (*see* p. 526). It is pleasanter to inhale, and forms a useful stimulating disinfectant expectorant inhalation in chronic bronchitis or laryngitis. To make an inhalation of it take of oil of Siberian fir, 45 ♏ (3 mils); rub with 20 gr. (12 decigrms. of light carbonate of magnesium, which helps to suspend it; add water, 1 fl. oz. (30 mils). Put 1 fl. dr. (4 mils) of this in a mixture of half a pint of cold-and half a pint of boiling water in a vessel so arranged that air drawn through the fluid can be inhaled.

Syrupus Pini (B. P. C.), containing oil of pine

and tincture of saffron—dose, ½ to 1 fl. dr., 2 to 4 mils.—is a good ingredient of expectorant mixtures.

Garlic, used medically for centuries, has been given for phthisis in the hope that its essential oil, Oleum Allii (see p. 563), which is powerfully antiseptic, will in its excretion through the lungs kill tubercle bacilli, but its taste and odour have prevented its extensive use. Yadil (trimethenal allylic carbide) claims to possess the antiseptic properties of garlic without its odour.

CLASS V. OF **Volatile Oils.**

Those used chiefly for their action on the kidneys and genito-urinary tract.

OIL OF JUNIPER.

Oleum Juniperi.—The oil distilled from the ripe fruit of *Juniperus communis*. North Europe.

CHARACTERS.—Colourless or pale yellow. Odour characteristic. Taste warm, aromatic. Sp. gr. 0·862 to 0·890.

COMPOSITION.—Oil of juniper is composed chiefly of terpenes, which are mostly pinene and cadinene.

Dose, ½ to 3 m.—3 to 18 centimils.

Preparation.

Spiritus Juniperi.—Oil of juniper, 1; alcohol (90 per cent.), 9.

Dose, 5 to 20 m.—3 to 12 decimils.

This is twice as strong as in B. P. 1898.

ACTION.

Oil of juniper acts as does oil of turpentine; but it is not so liable to upset digestion; and although a powerful renal stimulant and diuretic, it does not easily cause hæmaturia and albuminuria.

THERAPEUTICS.

It is not used externally. It is a stomachic, but its main use is as a diuretic in heart disease, hepatic ascites, and chronic Bright's disease. It must not be given in the acute form, and should always be combined with other diuretics. It causes the urine to smell like violets. As hollands and gin contain it,

these are good forms of alcohol for sufferers from the above diseases.

BUCHU.

Buchu Folia. *Synonym.*—Bucco. The dried leaves of *Barosma betulina.* Cape of Good Hope.

CHARACTERS.—From 12 to 20 millimetres long. Rhomboid ovate, glabrous, dull yellowish green, marked on the margins, especially the under surface, with oil-glands; peculiar strong odour; aromatic, mint-like taste. *Resembling buchu.*—Senna and Uva Ursi, which have entire leaves.

IMPURITY.—Leaves of *Emplanum serrulatum,* which have no glands.

COMPOSITION.—The chief constituents are—(1) A yellowish-brown volatile oil from the glands; it consists of barosma camphor in solution in a liquid hydrocarbon. The camphor is deposited on exposure to air. (2) A bitter principle. (3) Mucilage.

Preparations.

1. **Infusum Buchu.**—1 in 20 of boiling water.
Dose, 1 to 2 fl. oz.—30 to 60 mils.

2. **Tinctura Buchu.**—Buchu, 1; alcohol (60 per cent.), 5. Percolate.
Dose, ½ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTICS.

A medicinal dose of buchu causes a slight feeling of warmth in the stomach, and a large one gives rise to vomiting. The volatile oil diffuses into the blood and is excreted by the bronchial mucous membrane, which it stimulates, and buchu is therefore occasionally given as an expectorant. Most of the oil is excreted by the kidneys, which are also stimulated, and thus buchu is a mild diuretic. In the process of excretion it gives a peculiar odour to the urine, and acts as an astringent and disinfectant to the urinary tract, especially the bladder. It has consequently been administered for cystitis, irritable bladder, pyelitis, and gonorrhœa. Large doses continued for a long time are said to damage the kidneys. The infusion contains very little of the oil. Alcoholic solutions,

as the tincture, and a fluid extract which is sold, do not mix well with water on account of the oil in them. The action of buchu is much the same as that of pareira, but it is pleasanter to take, and is a good vehicle for diuretics.

COPAIBA.

Copaiba.—Copaiva. The oleo-resin obtained by incision from the trunk of various species of *Copaifera*. Valley of the Amazon, West and East Indies.

Characters.—A more or less viscous liquid, generally transparent and not fluorescent, but some varieties are opalescent and slightly fluorescent; light yellow to pale golden brown. Odour peculiar, aromatic; taste acrid, bitter. *Solubility.*—Not at all in water, almost entirely in absolute alcohol, ether, fixed and volatile oils, benzol, and in four times its bulk of petroleum.

Composition.—The chief constituents are—(1) *The official volatile oil*, 48 to 85 per cent. (*see below*). (2) *The resin*, 15 to 52 per cent. It exists dissolved in the oil. Dose, 10 to 20 gr. It is a brown resinous mass consisting of two resins: (*a*) copaivic acid ($C_{10}H_{30}O_2$), the chief constituent, a crystalline resin, with a faint odour, a bitter taste, insoluble in water, easily soluble in absolute alcohol and ammonia; (*b*) a non-crystallizable viscid resin, 1½ per cent.

Impurities.—Turpentine, detected by the smell on heating. Fixed oils; these leave a greasy ring round the resinous stain when heated on paper. Gurjun balsam, which coagulates at 130°C.; copaiba does not.

Dose, ½ to 1 fl. dr.—2 to 4 mils—in two and a half times as much mucilage of acacia.

Oleum Copaibæ.

Source.—The volatile oil distilled from copaiba.

Characters.—Colourless or pale yellow, with the taste and odour of copaiba. Sp. gr. 0·896 to 0·91.

Composition.—It consists chiefly of the hydrocarbon caryophyllene (*see* p. 541).

Dose, 5 to 20 m.—3 to 12 decimils—suspended in mucilage of acacia (1½ fl. oz. for every fl. oz. of oil of copaiba) or yolk of egg. Cinnamon or peppermint water, with tincture of orange or ginger, covers the taste. It may be dissolved in water with the aid of Liquor Potassæ, with which it forms a soap, or it may be given in capsules.

ACTION.

External.—Copaiba is a stimulant to the skin.

Internal.—*Gastro-intestinal tract.*—It acts like other volatile oils. Small doses produce a feeling of warmth in the epigastrium, but with large doses its irritant effect leads to vomiting and diarrhœa. Its taste is very nasty, and the eructations it may cause are very disagreeable.

Mucous membranes.—Here also it acts like other volatile oils. It is quickly absorbed, and is then excreted by all the mucous membranes, which it stimulates in its passage through them, increasing their vascularity and the amount of their secretion, which if foul is disinfected. Because of these actions it is a disinfectant **expectorant**, and a stimulating disinfectant to the whole of the **genito-urinary tract.** It imparts a powerful odour to the breath and mucous secretions. It is also excreted by the skin, and its irritant effect here is seen in the **erythematous** rash it often produces. Some, too, passes out by the milk.

Kidneys.—Copaiba has a more marked action on the kidneys than most substances containing volatile oils, and this is in great part due to the resin, which is particularly stimulating to the renal organs, and copaiba is therefore a useful **diuretic.** Large doses of it greatly irritate the kidney, as is shown by pain in the loins and blood and albumen in the urine. The oil and resin are excreted in the urine, and the resin can be thrown down from it by nitric acid; but this precipitate is known not to be albumen by the fact that it is evenly distributed through the fluid and is dissolved by heat. If the renal congestion is severe the urine may be very scanty.

THERAPEUTICS.

Genito-urinary tract.—Copaiba, or more usually its oil is largely used to stimulate and disinfect this

part of the body in cases of pyelitis, cystitis, vaginitis, and gonorrhœa. It is often prescribed for this last disease, and is best given when the acute symptoms have subsided, otherwise it may increase them.

Kidneys.—The resin which remains after distillation of the oil from copaiba is an admirable diuretic for hepatic and cardiac dropsy, but because of its liability to irritate the kidneys should not be given in Bright's disease. After a time patients seem to become accustomed to it, for the diuresis is not so marked as at first. It is nasty and difficult to make palatable. Fifteen grains (1 grm.) of the resin with 20 minims (12 decimils) of alcohol (90 per cent.), 15 grains (1 grm.) of compound tragacanth powder to suspend it, and a fluid drachm (4 mils) of syrup of ginger in an ounce (30 mils) of water may be given for a dose.

Bronchial mucous membrane.—Copaiba is occasionally used as a disinfectant expectorant when the secretion is very foul—as, for example, when the bronchial tubes are dilated.

Skin.—Copaiba has been given in chronic skin diseases, as psoriasis, for the cutaneous stimulation caused by it, but it is now quite discarded.

The reasons why it is rarely used except in gonorrhœa, for which it would not be employed if it had not such a strongly marked beneficial action, are that the smell of the breath of those taking it is very disagreeable, it is very nasty to the taste, and often causes indigestion.

CUBEBS.

Cubebæ Fructus.—Cubebs. The dried unripe full grown fruit of *Piper cubeba.* Java.

Characters.—Globular, 4 millimetres in diameter, blackish or greyish brown, wrinkled, tapering below into a rounded stalk, continuous with the pericarp, in which in the mature fruit is the seed, but in commercial specimens this is often so little

developed that the pericarp is almost empty. Odour aromatic. Taste warm, aromatic, bitter. *Resembling cubebs.*—Pepper and pimento; neither has a stalk.

COMPOSITION.—The chief constituents are—(1) *The official volatile oil*, 6 to 15 per cent. (*see below*). (2) An *oleo-resin*, 6 per cent., which contains much cubebic acid and cubebin. (3) Cubebin, a tasteless, insoluble, odourless substance. (4) Cubebic acid. (5) A little piperine.

Dose, 30 to 60 gr.—2 to 4 grms.

Preparation.

Tinctura Cubebæ.—Cubebs, 1; alcohol (90 per cent.), 5. Percolate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

Oleum Cubebæ.

SOURCE.—The volatile oil distilled from cubebs.

CHARACTERS.—Colourless or greenish yellow, with the odour and taste of cubebs. Sp. gr. 0·91 to 0·93.

COMPOSITION.—The chief constituents are—(1) Dipentene. (2) Cadinene. (3) Cubeb-camphor.

Dose, 5 to 20 m.—3 to 12 decimils—suspended in mucilage.

ACTION.

External.—Like other substances containing a volatile oil, cubebs is rubefacient when rubbed into the skin.

Internal.—Small doses are stomachic and carminative, and improve digestion, but moderate doses are very liable to cause dyspepsia. Cubebs enters the blood, and, like so many volatile oils, slightly stimulates the heart, and also excites the organs through which it is excreted. Occasionally, therefore, it causes an erythematous eruption on the skin; it increases and disinfects the bronchial secretion, and is consequently an expectorant; but its main action is on the genito-urinary passages, the mucous membrane of which is powerfully stimulated, and the secretions of which are disinfected. The kidneys are also irritated; hence cubebs is a diuretic. It

appears in the urine in a form (probably as a salt of cubebic acid) which may be precipitated by nitric acid.

THERAPEUTICS.

It is sometimes employed as lozenges, or as a powder, or as the smoke of cubebs cigarettes, to stimulate the mucous membrane in cases of slight bronchitis, chronic sore throat, or follicular pharyngitis. Chronic nasal catarrh and hay-fever have been treated by insufflations of the powder. Asthma is sometimes relieved by the cigarettes. Many popular bronchial troches contain cubebs; in them it exercises its expectorant action. Cubebs is rarely used as a stomachic or cardiac stimulant, because it is so liable to upset digestion; but as it is less likely to do so than copaiba, is a little pleasanter to take, and is almost as powerful a stimulant to the genito-urinary mucous membrane, it is largely used in gleet, gonorrhœa, and chronic cystitis.

OIL OF SANDAL WOOD.

Oleum Santali. *Synonym.*—Santal oil. The volatile oil distilled from wood of *Santalum album*. India.

CHARACTERS.—Thick, viscid, pale yellow. Odour strongly aromatic. Taste pungent, spicy. Readily soluble in alcohol, ether, or chloroform. Sp. gr. 0·973 to 0·985.

COMPOSITION.—It contains 90 per cent. of an alcohol, $C_{15}H_{25}OH$.

Dose, 5 to 30 m.—3 to 18 decimils—in capsules, or as an emulsion.

ACTION AND THERAPEUTICS.

The action of sandal-wood oil is the same as that of volatile oils in general, but, like that of the oils of copaiba and cubebs, it is especially manifested in the genito-urinary mucous membranes, which are stimulated and disinfected. The drug is used in gonorrhœa and gleet; it is pleasanter than copaiba, but

more expensive. It appears in the urine half an hour after administration. Some of it is excreted by the bronchial mucous membrane; it is therefore a stimulating disinfectant expectorant. Two or three drops on sugar will frequently relieve the hacking cough so often met with when but little sputum is expectorated.

GROUP VII.

Vegetable Bitters.

All these substances contain a bitter principle, which stimulates the functions of the stomach.

Calumba, Gentian, Quassia, Cascarilla, Chiretta, Serpentary, Picrorhiza, Dandelion, Orange Peel.

CALUMBA.

Calumbæ Radix.—Calumba Root. The dried, transversely cut slices of the root of *Jateorhiza columba*. From the forests of Eastern Africa north of the Zambesi.

Characters.—Flat, more or less circular slices, from $2\frac{1}{2}$ to 5 centimetres in diameter, and 3 to 12 millimetres thick. Cortical part thick, with a wrinkled brownish-yellow coat. Centre softer, concave, and greyish yellow; there is a fine dark line between the two parts. Mealy fracture. Musty odour; bitter taste.

Composition.—The chief constituents are—(1) *Calumbin*, $C_{21}H_{22}O_7$, a neutral bitter principle crystallizing in white needles. (2) Berberine, an alkaloid, giving the yellow colour. (3) Calumbic acid. (4) Starch, 33 per cent. No tannin is present, so calumba can be prescribed with salts of iron.

Preparations.

1. **Infusum Calumbæ.**—Calumba root, 1; cold water (to avoid extracting the starch), 20.

Dose, $\frac{1}{2}$ to 1 fl. oz.—15 to 30 mils.

2. **Tinctura Calumbæ.**—Calumba root, 1; alcohol (60 per cent.), 10. Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

ACTION.

External.—Calumba is a mild antiseptic and disinfectant.

Internal.—*Mouth.*—Calumba is a typical bitter; its main action is in the mouth, for the appetite is powerfully sharpened because the gustatory nerves are stimulated; this reflexly leads to dilatation of the gastric vessels and to a considerable increase in the gastric and salivary secretions.

Stomach.—The effects on the gastric mucous membrane which were brought about reflexly by the stimulation of the gustatory nerves are the only results of bitters on the stomach, for none follow their introduction through a fistula, but the increased gastric juice and the greater vascularity cause a feeling of hunger, and help the digestion of the food. Peristalsis in the stomach and intestine appears in some people to be made slightly more active, and thus calumba and other bitters may be carminative. Large doses have a paralytic effect on the secretion, and are very harmful. The long continued use of bitters leads to gastric catarrh and consequent indigestion.

Most bitters, like volatile oils, cause an increased migration of leucocytes from the intestinal glands into the blood.

Injected up the rectum bitters are anthelmintic, destroying the threadworm.

THERAPEUTICS.

Calumba is only employed to stimulate the gastric functions and improve the appetite in cases of chronic indigestion due to a general weakness of

action on the part of the stomach. It is thus an example of the large class of stomachics. It is especially valuable in that form of dyspepsia in which the stomach participates in a general feebleness of all the organs of the body, such as we see in anæmia, starvation, convalescence from acute diseases, tuberculosis, and general exhaustion. Bitters should never be used when there is acute or subacute gastritis, a gastric ulcer, or pain. They will obviously make all these conditions worse. They must not be too concentrated, nor be given for too long, lest they should over-irritate the stomach. They should always, as far as possible, be combined with modes of treatment designed to relieve the cause of the dyspepsia. Often they are called tonics; all that is meant by this is that, as they render the digestion of food more easy, the general health will improve. Most bitters, when given as rectal injections, are anthelmintics for the *Oxyuris vermicularis*. Half a pint of the infusion of calumba may be thrown up the rectum of an adult.

GENTIAN.

Gentianæ Radix.—The dried rhizome and root of *Gentiana lutea*. Central and Southern European mountains.

Characters.—Cylindrical, tough, brittle pieces or longitudinal slices, with irregular longitudinal furrows. The rhizome bears closely approximated leaf scars. Peripherally yellowish brown; centrally reddish yellow. Bark thick, reddish. Wood spongy, separated from bark by dark zone. Odour heavy, peculiar. Taste first sweet, then bitter.

Composition.—The chief constituents are—(1) *Gentiopicrin*, the active, very bitter glucoside, soluble in water and alcohol. Can be split up into glucose and gentiogenin. (2) Gentisic or gentianic acid united with gentio-picrin. (3) A trace of a volatile oil. (4) Gentianose, a sugar. Gentian contains no tannin, but cannot be prescribed with iron, because that darkens the colouring matter.

Incompatibles.—Iron salts, silver nitrate, and lead salts.

Preparations.

1. Extractum Gentianæ.—Aqueous.

Dose, 2 to 8 gr.—12 to 50 centigrms.

2. Infusum Gentianæ Compositum.—Gentian, 1; dried bitter orange peel, 1; fresh lemon peel, 2; boiling water, 80.

Dose, ½ to 1 fl. oz.—15 to 30 mils.

3. Tinctura Gentianæ Composita.—Gentian, 100; dried bitter orange peel, 37·5; cardamoms, 12·5; alcohol (45 per cent.), 1000. Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTICS.

Gentian has the same action as other bitters, such as calumba, and is employed for the same class of cases. It is more used than any other bitter, because its taste is pleasant and it is not astringent.

QUASSIA.

Quassiæ Lignum.—The wood of the trunk and branches of *Picræna excelsa*. Jamaica.

CHARACTERS.—In billets or logs, varying in size, but often as thick as a man's thigh, and covered with a dark grey bark. Wood dense, tough, porous, yellowish white. Often seen as chips, shavings, or raspings. Inodorous. Intensely bitter. *Resembling quassia.*—Sassafras, but this is aromatic and not bitter.

COMPOSITION.—The chief constituents are—(1) *Quassin*, a bitter neutral principle occurring in crystalline needles. (2) A volatile oil. No tannin is present, and therefore quassia can be prescribed with salts of iron.

Preparations.

1. Infusum Quassiæ.—Quassia, 1; cold water, 100. The water is cold to avoid extracting too much of the bitter principle.

Dose, ½ to 1 fl. oz.—15 to 30 mils.

2. Tinctura Quassiæ.—Quassia, 1; alcohol, 45 per cent.), 10. Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Action and Therapeutics.

Quassia is an aromatic bitter stomachic, acting in the same way as calumba. As it contains no tannin it is often prescribed with iron. The only objection to it is that some persons find it too bitter. Injected *per rectum*, it is an excellent anthelmintic for *Oxyuris vermicularis*; half a pint of the infusion may be given for this purpose.

CASCARILLA.

Cascarillæ Cortex.—The dried bark of *Croton eluteria.* Bahamas.

Characters.—Quills, 3 to 10 centimetres long, 4 to 12 millimetres in diameter. Externally greyish white cork, under that a dull brown cortex. Fracture brown, short, resinous. Odour agreeable, aromatic, especially when burned. Taste warm, bitter. *Resembling cascarilla.*—Pale cinchona, which is less white, smooth and small.

Composition.—The chief constituents are—(1) *Cascarillin,* a bitter neutral crystalline substance. (2) Volatile oils. (3) Resins. (4) Tannin.

Incompatibles.—Mineral acids. Lime water. Metallic salts.

Preparations.

1. Infusum Cascarillæ.—1 in 20 of boiling water.
Dose, $\frac{1}{2}$ to 1 fl. oz.—15 to 30 mils.

2. Tinctura Cascarillæ.—Cascarilla, 1; alcohol (70 per cent.), 5. Percolate.
Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

Action and Therapeutics.

Because of its bitter principle cascarillin, cascarilla, like other vegetable bitters, improves the digestion, and this stomachic and carminative action is aided by the volatile oils in it. It is pleasant to take, and is suitable for the same cases as calumba. The infusion will not keep good for more than a day unless a tincture is added to it. Mineral acids precipitate the resin from the tincture; therefore the infusion should be prescribed with them.

CHIRETTA.

Chirata.—The dried plant *Swertia chirata*, collected when in flower and dried. Northern India.

Characters.—Stem 1 metre or more long, rounded below, quadrangular, winged and much branched above; smooth, orange-brown or purplish; consists of a thin woody ring enclosing much yellow pith. Branches slender, decussate. Leaves opposite, entire, ovate, 5 to 7 ribbed. Flowers small, numerous, panicled. Root oblique. Odour none. Taste very bitter. *Resembling chiretta.*—Lobelia, which is not bitter.

Composition.—The chief constituents are—(1) *Chiratin*, an active bitter, amorphous principle. (2) Ophelic acid, with which it is combined. No tannin is present.

Preparations.

1. **Infusum Chiratæ.**—1 in 20 of boiling water. **Dose, ½ to 1 fl. oz.—15 to 30 mils.**

2. **Tinctura Chiratæ.**—Chiretta, 1; alcohol (60 per cent.), 10. Percolate. **Dose, ½ to 1 fl. dr.—2 to 4 mils.**

Action and Therapeutics.

Chiretta has the same actions and uses as gentian, calumba, and other bitters. As it contains no tannin, it can be given with iron. It is more used in India than in England.

SERPENTARY.

Serpentariæ Rhizoma.—Serpentary Rhizome. The dried rhizome and roots of *Aristolochia serpentaria* and of *Aristolochia reticulata*. North America.

Characters.—The rhizome of *A. serpentaria* is 3 millimetres thick, 2 centimetres long. Upper surface, remains of former stems; under surface, a tuft of slender rootlets, about 7 centimetres long. Dull yellowish brown. Odour aromatic, camphoraceous; taste bitter, aromatic, camphoraceous. The rhizome and roots of *A. reticulata* resemble the foregoing but are longer and thicker. *Resembling serpentary.*—Arnica, valerian (*q.v.*). The rhizome deteriorates by keeping.

Composition.—The chief constituents are—(1) A bitter principle, aristolochin. (2) A volatile oil. (3 Resin.

Preparation.

Tinctura Serpentariæ.—Serpentary, 1; alcohol (70 per cent.), 5. Percolate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Serpentary is contained in Tinctura Cinchonæ Composita.

ACTION AND THERAPEUTICS.

In the small doses in which serpentary is given in medicine it is a bitter stomachic, acting just like calumba or cascarilla, and it is used for the same class of cases. It is rarely prescribed alone. In large doses it produces vomiting and purging. Many virtues have been attributed to it which it does not possess.

PICRORHIZA.

Picrorhiza.—The dried rhizome of *Picrorhiza kurroa.*

CHARACTERS.—Generally about the size of a goose-quill, the lower part covered by a shrivelled, greyish brown, corky bark, and marked by prominent leaf scars and small buds. Taste very bitter.

Dose, 10 to 20 gr.—6 to 12 decigrms.—as a tonic; **45 to 60 gr.—3 to 4 grms.**—as an antiperiodic. Given in powder.

Preparations.

1. **Extractum Picrorhizæ Liquidum.**—1 in 1 of alcohol (60 per cent.). Percolate.

Dose, 15 to 60 m.—1 to 4 mils.

2. **Tinctura Picrorhizæ.**—1 in 4 of alcohol (45 per cent.). Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

This is twice the strength of the preparation in Addendum 1900 to B. P. 1898.

ACTION AND THERAPEUTICS.

This drug, which is known as 'kali-kutki,' is extremely bitter and is usually given combined

with aromatics as a bitter. It is also used as an antiperiodic. Used chiefly in India and the East Indies.

DANDELION ROOT.

Taraxaci Radix.—The fresh roots of *Taraxacum officinale*. Collected in the autumn.

CHARACTERS.—About 3 decimetres long, 12 millimetres in diameter. Externally smooth, yellowish brown. Internally white. Milky juice. Fracture short, showing yellow, porous, woody axis, with irregular concentric rings and a thick whitish bark. No odour. Taste bitter. *Resembling taraxacum.*—Pellitory, which is pungent when chewed.

COMPOSITION.—The chief constituents are—(1) Taraxacin, a neutral principle. (2) Taraxacerin. (3) Asparagin (found also in asparagus, marsh-mallow, liquorice, euonymus, &c.), of no therapeutical value. (4) Inulin, mannite. (5) Salts. (6) Resins (which give the juice its milky appearance).

Preparations.

1. **Extractum Taraxaci.**—Fresh extract. Made by evaporating the juice pressed out from the *fresh root.*

Dose, 5 to 15 gr.—3 to 10 decigrms.

2. **Succus Taraxaci.**—*Fresh juice*, 3; alcohol (90 per cent.), 1.

Dose, 1 to 2 fl. dr.—4 to 8 mils.

ACTION AND THERAPEUTICS.

Dandelion is a simple bitter, and acts as a stomachic, just like calumba. It is also slightly laxative. It was formerly much more used than at the present day. It has been said to stimulate the flow of bile, but this is incorrect.

ORANGE PEEL.

Aurantii Cortex Recens.—Fresh Bitter Orange Peel. The fresh outer part of the pericarp of *Citrus aurantium* (var. *Bigaradia*).

CHARACTERS well known.

Preparations.

1. Tinctura Aurantii.—Fresh bitter orange peel, 1; alcohol (90 per cent.), 4. Macerate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

2. Syrupus Aromaticus.—Tincture of orange, 1; cinnamon water, 1; syrup, 2. *Synonym.*—Simple Elixir.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

3. Syrupus Aurantii.—Tincture of orange, 125; syrup, to produce 1000.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

4. Vinum Aurantii.—A saccharine solution to which fresh bitter orange peel has been added is fermented. It contains 12 to 14 per cent. of alcohol.

Vinum Aurantii is used to make Vinum Ferri, Citratis and Vinum Quininæ.

Tinctura Aurantii is contained in Confectio Sulphuris, Syrupus Cascaræ Aromaticus, Tinctura Quininæ, and Trochisci Sulphuris.

Aurantii Cortex Siccatus.—Dried Bitter Orange Peel. The dried outer part of the pericarp of *Citrus aurantium* (var. *Bigaradia*).

Characters.—Thin pieces or strips, dark yellow colour, almost free from the white inner rind. Odour fragrant. Taste aromatic and bitter.

Composition.—The chief constituents are—(1) A fixed oil, *Oleum Corticis Aurantii,* 1 to 2 per cent. Sp. gr. 0·84 to 0·86, which consists chiefly of a terpene, dextro-rotatory limonene, $C_{10}H_{16}$. This oil is an ingredient of several elixirs. (2) Three glucosides, hesperidin, isohesperidin, aurantiamarin (the bitter principle).

Preparations.

1. Infusum Aurantii.—Dried bitter orange peel, 1; boiling water, 20.

Dose, ½ to 1 fl. oz.—15 to 30 mils.

2. Infusum Aurantii Compositum.—Dried bitter orange peel, 25; fresh lemon peel, 10; cloves, 5; boiling water, 1000.

Dose, ½ to 1 fl. oz.—15 to 30 mils.

Dried bitter orange peel is contained in Spiritus Armoraciæ Compositus, Tinctura Cinchonæ Composita, Infusum Gentianæ Compositum, Tinctura Gentianæ Composita.

Aurantii Cortex Indicus.—The fresh and dried outer part of the pericarp of varieties of *Citrus aurantium* grown in India and Ceylon. This is in India and the Eastern Colonies used for the same purposes as orange peel elsewhere

Aqua Aurantii Floris.—Orange Flower Water. The orange flower water of commerce prepared by distillation from the flowers of *Citrus aurantium* (var. *Bigaradia*) (the bitter orange tree). It is a saturated solution of the essential oil of the fresh flowers. In dispensing it is diluted with twice its volume of distilled water immediately before use.

CHARACTERS.—Colourless or slightly greenish; very fragrant; bitter taste.

COMPOSITION.—The chief constituents are—(1) A volatile oil, *Oleum Neroli*. (2) A bitter principle.

Dose, ½ to 1 fl. oz.—15 to 30 mils.

Preparation.

Syrupus Aurantii Floris.—Orange flower water of commerce, undiluted, 150; sugar, 300; syrup to make 1000.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Orange flower water, undiluted, is contained in Mistura Olei Ricini, and in Syrupus Calcis Lactophosphatis.

ACTION AND THERAPEUTICS.

The various preparations of the orange are used largely as flavouring agents, and Syrupus Aromaticus is especially useful. They are slightly bitter and stomachic.

GROUP VIII.

Vegetable Drugs containing Tannic Acid.

These are all astringent.

Galls, Catechu, Rhatany, Kino, Logwood, Hamamelis, Eucalyptus Gum, Acacia Bark, Bael Fruit, Myrobalans.

Galla.—Galls. Excrescences on *Quercus infectoria*, caused by the puncture and deposit of the eggs of *Cynips gallæ tinctoriæ*.

CHARACTERS.—Hard, heavy, subglobular, 12 to 18 millimetres in diameter; tuberculated on surface; the tubercles and the intervening spaces are smooth; dark bluish green or dark olive-green externally; yellowish or brownish white within, with small central cavity. Odour none. Taste first astringent, then sweetish.

COMPOSITION.—The chief constituents are—(1) *Tannic acid*, 60 to 75 per cent. (2) *Gallic acid*, 2 to 5 per cent.

INCOMPATIBLES, *see* Tannic and Gallic Acids.

Preparations.

1. **Unguentum Gallæ.**—Galls, 1; benzoated lard, 4.

In India benzoated suet should be used instead of benzoated lard.

2. **Unguentum Gallæ cum Opio.**—Ointment of galls, 925; opium, 75. *Strength.*—This contains 7·5 per cent. of opium.

Acidum Tannicum.—Tannic Acid. *Synonyms.*—Tannin, Digallic acid. $C_{14}H_{10}O_9$.

SOURCE.—Tannic acid may be extracted by water saturated with ether from galls which have been subjected to a special fermentation.

CHARACTERS.—A pale brownish powder, consisting of thin glistening scales. Taste strongly astringent. Reaction acid. *Solubility.*—Freely in water or alcohol (90 per cent.); 1 in 1 of glycerin; 1 in 100 of ether. Gives a yellowish-white precipitate with gelatin (gallic acid does not), and this is the action that takes place when hides are tanned. There are many varieties of tannic acid in pharmacopœial plants. They all have a benzene nucleus, and mostly exist in glucosides.

INCOMPATIBLES.—Mineral acids, alkalies. Salts of antimony, lead, silver, per-salts of iron. Alkaloids, gelatin, emulsions.

Dose, 5 to 10 gr.—3 to 6 decigrms.—rarely given internally.

Preparations.

1. **Glycerinum Acidi Tannici.**—Tannic acid, 20; glycerin, 100.

2. Suppositoria Acidi Tannici. — Tannic acid, 2·4 grms.; oil of theobroma q.s. to make twelve suppositories.

Each contains 0·2 grms. (about 3 grs.) of tannic acid.

3. Trochiscus Acidi Tannici.—0·03 grm. or ½ gr. in each, with a tolu basis.

Action.

External.—Tannic acid is an important drug, because it coagulates proteins with great readiness; that is to say, it tans the tissues, for it is by coagulating the interstitial fluids in skins that tannic acid converts them into leather. The coagulated protein powerfully resists putrefaction. If an albuminous discharge is taking place from a sore or mucous surface and tannic acid is applied, the excreted fluid is coagulated, and the dense, insoluble coagulum forms a solid protecting layer which prevents further discharge. As the tannic acid soaks into the tissues it coagulates the albuminous fluids there also, and this still further hinders the discharge of fluid, therefore it is an energetic astringent. If bleeding is taking place, tannic acid of course coagulates the blood as it flows and the clots plug the vessels; at the same time the coagulum formed within the tissues, by its contraction, constricts the blood-vessels, and thus tannic acid becomes a powerful hæmostatic. It has no noteworthy direct effect on the vessels themselves. Tannic acid is mildly depressant to sensory nerves. Like other acids it is irritant, but it is very feebly so, and consequently its action in this direction is more than counterbalanced by its strongly astringent effects.

Internal. — *Gastro-intestinal tract.* — Because tannic acid coagulates the mucous secretions and the fluids in mucous membranes, it makes the mouth dry and feel stiff when locally applied; in

the stomach large doses prevent the secretion of gastric juice, decrease the flow of mucus, and may cause vomiting. For these reasons, and also because it precipitates proteins and pepsin, it interferes with digestion, but less than might be thought, because the precipitated protein is slowly broken up and converted into peptones, and they are not precipitated by tannic acid in an acid medium. It will check gastric hæmorrhage. In the intestine it is either converted into gallic acid or forms alkaline tannates, and until these alterations it acts as an intestinal astringent, controlling intestinal bleeding and causing constipation; but gallic acid and alkaline tannates have no astringent properties, therefore when drugs containing large amounts of tannic acid act as powerful intestinal astringents and hæmostatics, we must suppose that the amount of tannic acid taken is large enough for the conversion of it into salts or gallic acid, to take place slowly. Its administration leads to constipation, and the fæces are particularly hard.

It is absorbed chiefly as gallates, and to a much less extent as tannates.

Remote effects.—Gallates and undecomposed alkaline tannates circulate in the blood, but they have no power to coagulate albumen, nor have they any astringent influence when locally applied, therefore it is difficult to believe that tannic acid has any remote astringent or hæmostatic effects; some claim that it has, but they have not proved their case. It is excreted in the urine of animals as gallates with traces of tannates, but in man no derivative of it can be detected in the urine or other secretions, so that any which has been absorbed is entirely decomposed in the body. Any excess passes out in fæces as tannates and gallates. Many vegetable substances, such as logwood, depend, for their astringent properties, on the tannic acid they contain.

THERAPEUTICS.

The therapeutical applications of tannic acid are very numerous. It is used as an astringent for ulcers, sores, various moist eruptions, tonsilitis, pharyngitis, nasal catarrh, otorrhœa, gastric catarrh, diarrhœa (large doses of 30 grains may be given; catechu and logwood are favourite remedies), leucorrhœa, gonorrhœa, rectal ulcers, fissures, and prolapse. It is employed as a hæmostatic in bleeding from small wounds, ulcers, the gums, the pharynx, the nose, the stomach, the intestine, hæmorrhoids, and the bladder. Collodium Stypticum (B. P. C.) contains tannin, and is a useful external remedy. Whenever practicable a good method of application is to dust tannic acid on the part, especially for hæmorrhage; if this is gastric or intestinal 30 grains (2 grms.) or more should be frequently given by the mouth. For external use or for application to the throat the glycerinum is useful. A gargle of 1 fl. dr. (4 mils) of the glycerinum to 1 fl. oz. (30 mils) of water may be made. The lozenges are convenient for pharyngitis. A spray (6 to 10 gr., 40 to 60 centigrms., in 1 fl. oz., 30 mils, of water) or an insufflation of tannic acid and starch may be used for the mouth and larynx. The ointment of galls and opium is a favourite application for piles. The suppositories are useful for rectal discharges. Solutions of 10 gr. (6 decigrms.) to 1 fl. oz. (30 mils) of water may be injected into the urethra for gonorrhœa and urethritis, and into the bladder for cystitis. A decoction of oak bark, employed as a rectal injection, destroys the threadworm. Tannigen (diacetyl tannin) and Tannalbin (tannin and albumen) have been recommended for diarrhœa. They may be given in 10-grain (6 decigrms.) doses in a cachet. Tannoform (tannin and formic aldehyde) is used as a dusting powder.

Acidum Pyrogallicum. — Trihydroxybenzol. (Not official.)

Synonym.—Pyrogallol. $C_6H_3(OH)_3$.

Source.—Obtained by heat from gallic or tannic acid, but chemically it is related to phenol.

Characters.—Light, small, white crystals. Odour, none. *Taste.*—It produces a feeling of coldness on the tongue. *Solubility.*—1 in $2\frac{1}{2}$ of water; 1 in 10 of lard.

Action and Therapeutics.

It is used externally as an ointment (Jarisch's ointment is pyrogallic acid, 60 gr., 4 grms.; lard, 1 oz., 32 grms.) for the treatment of chronic psoriasis. Jarisch's ointment is very strong; a more usual strength is one-sixth or one-third of the above. Pyrogallic acid is also an excellent parasiticide for ringworm. It must not be applied over too large a surface, as it may be absorbed, and then it breaks up the blood-corpuscles, causing methæmoglobinuria and jaundice. It is too powerful a poison to give internally.

CATECHU.

Catechu. *Synonyms.*—Pale catechu, Catechu Pallidum. An extract of the leaves and young shoots of *Uncaria gambier*. Prepared at Singapore and other places in the Eastern Archipelago.

Characters.—In cubes (sometimes agglutinated), each side 25 millimetres, deep reddish brown externally, pale brown internally; dull, earthy fracture, under the microscope showing myriads of small acicular crystals. Odourless. Taste at first astringent, bitter, then sweet. Entirely soluble in boiling water.

Composition.—The chief constituents are—(1) *Catechutannic acid*, 40 per cent., the active principle, isomeric with catechin, and converted into it by boiling or by the saliva, a red colour being formed. (2) Catechin or catechuic acid, probably inactive. (3) Pyrocatechin or catechol, $C_6H_4(OH)_2$, gives a green colour with ferric chloride. Pyrocatechin is found pathologically in the urine and gives it a dark colour.

Incompatibles.—Alkalies, metallic salts, and gelatin.

Impurity.—Starch.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Preparations.

1. Pulvis Catechu Compositus.—Catechu, 4; kino, 2; rhatany, 2; cinnamon, 1; nutmeg, 1. *Strength* of catechu, 4 in 10.

Dose, 10 to 60 gr.—6 to 40 decigrms.

2. Tinctura Catechu.—Catechu, 4; cinnamon, 1; alcohol (60 per cent.), 20. Macerate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

3. Trochiscus Catechu.—0·06 grm. or 1 gr. in each with a fruit basis.

Catechu Nigrum. *Synonym.*—Black Catechu. An extract from the wood of *Acacia catechu.*

CHARACTERS.—Irregular dark brown masses, brittle, porous, glossy fracture.

It is only in Great Britain that both pale and black catechu are official; in all other countries only black catechu is official, as it is much more constant and powerful than the pale catechu. In India, the East generally, and North America it may be used to make the preparations for which pale catechu is directed to be used.

Dose, 5 to 15 gr.—3 to 10 decigrms.—in powder.

ACTION AND THERAPEUTICS.

Catechu is a powerful astringent, acting in virtue of its tannic acid, and having a precisely similar action to it. It is used as a lozenge for sore throats, and the other preparations, especially the compound powder, are very efficacious for diarrhœa.

RHATANY.

Krameriæ Radix.—Krameria Root. *Synonym.*—Rhatany Root. The dried root of (1) Para Rhatany, a species of *Krameria* probably *Krameria argentea*; or of (2) Peruvian Rhatany, *Krameria triandra.*

CHARACTERS.—(1) Para. — Cylindrical pieces, purplish-brown, smooth thick bark which adheres closely to the wood and has deep cracks. Wood, fracture short, colour reddish-brown. (2) Peruvian.—Dark reddish-brown yellow, woody axis. The bark separates easily, is thinner than that of Para, mostly rough and scaly. The bark of both kinds is strongly astringent, and tinges the saliva red.

Composition.—The chief constituents are—(1) *Rhatanhia-tannic acid*, 20 per cent. (2) Rhatanhia red, the colouring matter. (3) Rhatannin, a neutral substance.

Incompatibles.—Alkalics, lime water, salts of iron and lead, and gelatin.

Preparations.

1. **Extractum Krameriæ.**—Aqueous.
Dose, 5 to 15 gr.—3 to 10 decigrms.

2. **Infusum Krameriæ.**—1 in 20 of boiling water.
Dose, $\frac{1}{2}$ to 1 fl. oz.—15 to 30 mils.

3. **Pulvis Catechu Compositus.**—Catechu, 4; kino, 2; krameria, 2; cinnamon, 1; nutmeg, 1.
Dose, 10 to 60 gr.—6 to 40 decigrms.

4. **Tinctura Krameriæ.**—Powdered krameria root, 1; alcohol (60 per cent.), 5. Percolate.
Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

5. **Trochiscus Krameriæ.**—0·06 grm. or 1 gr. of the extract of krameria in each with a fruit basis.

6. **Trochiscus Krameriæ et Cocainæ.**—Extract of krameria, 0·06 grm.; cocaine hydrochloride, 0·003 grm. Fruit basis. This lozenge contains 0·003 grm. or $\frac{1}{20}$ gr. of cocaine hydrocloride.

Action.

The action of rhatany is due entirely to the tannic acid it contains. It is therefore a powerful astringent.

Therapeutics.

The powdered extract is the important ingredient of many tooth powders which are useful when the gums are liable to bleed. The infusion is an excellent gargle for a relaxed throat, and the lozenges are also efficacious, those of rhatany and cocaine being specially serviceable. Bleeding from the nose or the rectum may be stopped by applying powdered rhatany root locally; the infusion may be used as an injection in leucorrhœa and gonorrhœa. Any of the preparations, especially the compound catechu

powder, are powerful astringents for all varieties of diarrhœa, and may be taken to stop bleeding from the stomach and intestines. They are also given as remote hæmostatics for hæmoptysis and hæmaturia, but they are not reliable for these purposes.

KINO.

Kino.—The juice obtained from incisions into the trunk of *Pterocarpus marsupium*, heated to boiling and evaporated to dryness. Known in commerce as East Indian, Malabar, Madras, or Cochin Kino.

CHARACTERS.—Small, angular, glistening, reddish-black, brittle fragments. In thin pieces, and at the edges translucent and ruby-red. Inodorous. When chewed, sticks to the teeth and colours the saliva blood-red. *Solubility.*—Easily in alcohol (90 per cent.), also in boiling water, partially in cold.

COMPOSITION.—The chief constituents are—(1) *Kino-tannic acid*, 75 per cent. (2) Kinoin, a crystalline neutral substance. (3) Pyrocatechin, $C_6H_4(OH)_2$ (*see* p. 592). (4) Kino red, formed from kino-tannic acid by oxidation. (5) Gum.

INCOMPATIBLES.—Mineral acids, alkalies, all metallic salts, carbonates, gelatin.

Dose, 5 to 20 gr.—3 to 12 decigrms.

Preparations.

1. Pulvis Kino Compositus. — Kino, 15; opium, 1; cinnamon, 4. *Strength* of opium, 5 per cent.

Dose, 5 to 20 gr.—3 to 12 decigrms.

2. Tinctura Kino. — Kino, 10; glycerin, 15; water, 25; alcohol (90 per cent.), to make 100. Macerate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

3. Pulvis Catechu Compositus.—2 in 10 (*see* p. 593).

ACTION AND THERAPEUTICS.

Kino-tannic acid acts like tannic acid, and therefore kino is a powerful astringent. It is used in astringent gargles, and also in diarrhœa mixtures.

BENGAL KINO.

Buteæ Gummi.—The inspissated juice from incisions of the stem of *Butea frondosa.*

Characters.—Small, irregular, shining fragments of a very dark ruby colour.

Action and Therapeutics.

Butea gum, commonly called Bengal kino, is in India and the East Indies used for the same purposes and to make the same preparations as the ordinary kino.

LOGWOOD.

Hæmatoxyli Lignum.—Logwood The heartwood of *Hæmatoxylon campechianum.* Campeachy, Honduras, and Jamaica.

Characters.—The logs, in which form it is imported, are hard, heavy, orange or purple red externally, and internally reddish brown. The chips are reddish brown. Odour agreeable, peculiar. Taste sweetish, astringent. When chewed the saliva is coloured reddish pink. *Resembling logwood.*—Red sanderswood, which is more dense and less astringent.

Composition.—The chief constituents are—(1) *Tannic acid.* (2) Hæmatoxylin, $C_{16}H_{14}O_6$, 12 per cent. Occurring in colourless crystals, which become dark red on exposure to light and air. Solutions of it are used to stain histological specimens.

Incompatibles.—Mineral acids, lime water, and tartar emetic; metallic salts give a blue colour.

Preparation.

Decoctum Hæmatoxyli.—Logwood, 50; cin namon bark, 10; water, to 1000.

Dose, ½ to 2 fl. oz.—15 to 60 mils.

Action and Therapeutics.

In virtue of its tannic acid logwood is a powerful astringent, and for this purpose is used to control diarrhœa of all sorts. It may be combined with other astringents, as chalk and opium. It does not

easily produce constipation. It colours the urine and fæces dark red. One disadvantage of it is that it stains linen if dropped on it.

HAMAMELIS.

Hamamelidis Cortex.—The dried bark of *Hamamelis virginiana*, the witch-hazel. United States. *Synonym.*—Witch hazel bark.

CHARACTERS.—Curved pieces ½ to 2 decimetres long, 1½ millimetres thick. Scaly, silver-grey outer bark marked with lenticels, but often free from outer bark and then smooth reddish brown. Interior bright brownish red, striated longitudinally. Taste astringent.

COMPOSITION.—The chief constituents are—(1) *Tannic acid*, 8 per cent. (2) A volatile principle not yet isolated. (3) A little colouring matter.

Preparation.

Tinctura Hamamelidis.—Hamamelis bark, 1; alcohol (45 per cent.), 10. Percolate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Hamamelidis Folia.—The fresh or dried leaves of *Hamamelis virginiana*.

CHARACTERS.—7 to 15 centimetres long, 3 to 4 in. broad, oval, apex obtuse, oblique at the base, dark brown green above, pale below. Veins prominent. Odour slightly tea-like. Taste astringent, bitter.

COMPOSITION.—The same as of the bark, but the leaves contain rather less tannin. The fresh are more active than the dried.

Preparations.

1. **Extractum Hamamelidis Liquidum.**—Hamamelis leaves, powdered, 1000, percolated with alcohol (45 per cent.), 1000.

Dose, 5 to 15 m.—3 to 10 decimils.

2. **Liquor Hamamelidis.**—Fresh leaves, 100; water, 200; alcohol (90 per cent.), 16. Macerate and distil.

3. **Unguentum Hamamelidis.**—The liquid extract, 1; wool fat, 6; soft paraffin, 3.

Action and Therapeutics.

Hamamelis is, because of its tannic acid, astringent and hæmostatic. The liquid extract or the tincture is used for capillary hæmorrhage from wounds, for bleeding from the nose, the sockets of the teeth, the gums, or from piles, and either may be injected into the bladder in vesical hæmorrhage. For all these purposes they are diluted with water; the fluid may be any strength; 1 of the tincture to 10 or 20 of water is commonly employed. Locally applied, hamamelis, either as the ointment or a dilute fluid preparation, such as the liquor, is used as an astringent in bruises, sprains, pharyngitis, and nasal catarrh. The ointment is often used for piles. Given by the mouth, hamamelis may check diarrhœa and dysentery; and it is reputed to be a remote hæmostatic and astringent, but this is probably incorrect. Hazeline is a distilled extract from the leaves.

EUCALYPTUS KINO.

Kino Eucalypti. *Synonyms.*—Eucalyptus gum (B. P. 1898), red gum. An exudation from the stem of various species of *Eucalyptus*. Australia.

Characters.—Dark reddish-brown grains or small masses. Tough. Adheres to the teeth when chewed. Taste astringent. Soluble in water. *Resembling eucalyptus kino.*—Kino, which is darker and feebly soluble in water.

Composition. — The chief constituents are—(1) *Kino-tannic acid.* (2) Catechin. (3) Pyrocatechin (*see* p. 592).

Dose, 5 to 20 gr.—3 to 12 decigrms.

Preparation.

Trochiscus Kino Eucalypti.—0·06 grm. or 1 gr. in each with a fruit basis.

Action and Therapeutics.

Eucalyptus gum is, in virtue of its tannic acid, powerfully astringent, and is used for diarrhœa and dysentery. The lozenges, or a decoction of 1 in 40

as a gargle, are employed for relaxed throats. This decoction may also be given in doses of 2 to 4 fl. dr. (8 to 16 mils) for diarrhœa. A liquid extract (red gum, 7; water, 21; alcohol [90 per cent.], 1: dose, ½ to 1 fl. dr., 2 to 4 mils) is a useful preparation. Injected into the nose it stops epistaxis. Mixed with 1 in 10 of water it may be injected into the rectum or vagina, or may be used as a mouth wash. Suppositories, each containing 5 gr. (3 decigrms.) of red gum, are prepared, and may be employed for piles.

ACACIA BARK.

Acaciæ Cortex.—The dried bark of *Acacia arabica*, also of *Acacia decurrens*, obtained from wild or cultivated trees not less than seven years old, and, after being dried, kept one year before use.

Characters.—Hard, brown, the inner surface red. Taste astringent.

Used chiefly in India, Australian Colonies, Eastern Colonies.

Preparation.

Decoctum Acaciæ Corticis.—Bark 60 grms.; water 1000 millilitres.

Dose, ½ to 2 fl. oz.—15 to 60 mils.

Action and Therapeutics.

This bark contains much tannin, and is therefore powerfully astringent, being used especially as a gargle and mouth-wash, and for vaginal discharges. It is used in tanning.

BAEL FRUIT.

Belæ Fructus.—The fresh half-ripe fruit of *Ægle marmelos*.

Characters.—Seven or eight centimetres in diameter, globular, smooth. Ten to fifteen cells, each containing woolly seeds. Pulp juicy, drying an orange red colour.

Preparation.

Extractum Belæ Liquidum.—Bael fruit, 10; chloroform water, 150; evaporate to 75 and add alcohol (90 per cent.) to produce 100.

Dose, 1 to 2 fl. dr.—4 to 8 mils.

Action and Therapeutics.

As imported into England bael fruit is useless; it is therefore rarely employed out of India, where the extract of the fresh fruit is used for the treatment of diarrhœa and dysentery. It contains a little tannin, and its mode of action is not known.

MYROBALANS.

Myrobalanum. *Synonym.*—Chebulic myrobalans. The dried immature fruits of *Terminalia chebula.*

Characters.—Ovoid or fusiform; 10 to 30 millimetres long, 5 to 15 millimetres wide; shrivelled longitudinally; black, solid, brittle. Taste very astringent.

Dose, 30 to 60 grs.—2 to 4 grms.—in powder.

Preparations.

1. **Unguentum Myrobalani.**—Myrobalans, 1; benzoated lard, 4. In India benzoated suet should be used instead of benzoated lard.
2. **Unguentum Myrobalani cum Opio.**—Myrobalan ointment, 925; opium in powder, 75. *Strength.*—7·5 per cent. of opium.

Action and Therapeutics.

These fruits contain from 25 to 45 per cent. of tannin, and they may be used for the same purposes as other bodies which contain tannin. They are used chiefly in India and the East Indies. The fresh fruit is aperient and is often used for this property.

GROUP IX.

Vegetable Demulcent Substances.

Many of these are nutritive.

Olive Oil, Arachis Oil, Sesame Oil, Soap, Glycerin, Oleic Acid, Almonds, Tragacanth, Gum Acacia, Indian Gum, Liquorice, Linseed, Spogel Seeds, Sugar, Malt, Soya Beans.

OLIVE OIL.

Oleum Olivæ.—The oil expressed from the ripe fruit of *Olea europæa*, and refined. South Europe.

CHARACTERS.—A pale yellow or greenish yellow fluid. Odour faint. Taste oleaginous. Sp. gr. 0·915–0·918.

COMPOSITION.—The two constituents are—(1) *Olein*, 72 per cent., a fluid oil, a compound of oleic acid and glyceryl, thus: $C_3H_5(C_{18}H_{33}O_2)_3$. (2) *Palmitin*, nearly 28 per cent., a solid oil, a compound of palmitic acid and glyceryl, $C_3H_5(C_{16}H_{31}O_2)_3$. The formula for oleic acid is $C_{18}H_{34}O_2$; and for palmitic, $C_{16}H_{32}O_2$. Olive oil is much adulterated, especially with sesame oil and cotton-seed oil.

Olive oil is contained in many plasters, ointments, and liniments. From it are made hard soap, soft soap, and glycerin.

ACTION AND THERAPEUTICS.

External.—Olive oil is used to facilitate the rubbing of parts; for this purpose it is employed in massage. It is a common soothing protective to burns (*see* Linimentum Calcis, p. 162), and may be mixed with poultices to prevent their sticking to the skin. If rubbed in vigorously, it can be absorbed through the epidermis, and might be thus used as a food when nourishment cannot be given by the mouth.

Internal.—For its soothing protective qualities it may be swallowed after corrosive poisons have been taken. All fats retard gastric and accelerate pancreatic secretion. Because olive oil retards the flow of the

gastric juice it is an excellent food in cases of gastric ulcer, for the acid prevents the healing of the ulcers. It is a good mild laxative, and can be given with food for this purpose. Some persons like it, with others it excites nausea and vomiting. An olive oil enema (warm olive oil, 5 fl. oz.—150 mils; with or without warm mucilage of starch, 8 fl. oz.—240 mils) is often used to open the bowels when a mild non-irritating injection is required.

A gall-stone placed in pure olive oil at the temperature of the body is slowly dissolved, because cholesterin, which is the chief constituent of gall-stones, is soluble in olive oil. It is also soluble in oleic acid and in animal soaps. Many patients suffering from gall-stones derive much benefit from taking olive oil. Possibly this is because the oil or some of its constituents are excreted by the bile, and to a much less extent because the intestinal peristalsis set up by the olive oil extends to the bile ducts. From 2 to 8 fl. oz. (60 to 240 mils) should be taken daily. It may be mashed with fish or potato. Some people take it better if a few grains of menthol and a drachm (4 mils) of brandy are added to each 8 fl. oz. (240 mils) of oil. If it disagrees, oleic acid (*q.v.*) may be tried. Eunatrol, consisting of 70 per cent. of sodium oleate with 30 per cent. of oleic acid, has been successfully used in cases of gall-stones. Thirty to forty-five grains (2 to 3 grms.) may be given in a day. It is best prescribed as pills.

Olive oil is a food, and is the best means of giving food subcutaneously; 15 c.c. of sterilized oil may be injected under the skin twice a day. This yields about 280 calories, and is an aid to rectal feeding (*see* p. 616).

ARACHIS OIL.

Oleum Arachis. *Synonyms.*—Earth-nut oil, ground-nut oil, pea-nut oil. The oil expressed without heat from the seeds of *Arachis hypogæa.*

CHARACTERS.—Pale yellow or greenish yellow; nut-like odour. Sp. gr. 0·916 to 0·921.

USES.

Used in India, African Colonies, Eastern Colonies, and Australasian Colonies, instead of olive oil, to make liniments, ointments, and plasters.

SESAME OIL.

Oleum Sesami.—The oil expressed from the seeds of *Sesamum indicum*.

CHARACTERS.—A limpid oil of a pale yellow colour, a faint odour, and a bland taste. Sp. gr. 0·921 to 0·924.

USES.

Used in India, African Colonies, Eastern Colonies, and North American Colonies, instead of olive oil, to make liniments, ointments, and plasters.

SOAP.

Sapo Durus.—Hard soap. It is sodium oleate, $NaC_{18}H_{33}O_2$, containing 30 per cent. of water. It is rarely pure, almost always containing some alkaline hydroxide or carbonate.

SOURCE.—Made by acting on olive oil with caustic soda. $C_3H_5(C_{18}H_{33}O_2)_3 + 3NaHO = 3NaC_{18}H_{33}O_2$ (hard soap) $+ C_3H_5(OH)_3$ (glycerin).

Preparations.

1. Emplastrum Saponis.—Hard soap, 140; lead plaster, 835; resin, 25.

2. Pilula Saponis Composita.—Opium, 1 hard soap, 3; syrup of glucose, 1. *Strength of Opium*, 20 per cent.

Dose, 2 to 4 gr.—12 to 25 centigrms.

Hard soap is used to make many pills.

Sapo Mollis.—Soft Soap. It is potassium oleate, $KC_{18}H_{33}O_2$. It is rarely pure, almost always containing some alkaline hydroxide or carbonate.

Source.—Made by acting on olive oil with caustic potash. $C_3H_5(C_{18}H_{33}O_2)_3 + 3KHO = 3KC_{18}H_{33}O_2 + C_3H_5(OH)_3$ (glycerin).

Preparation.

Linimentum Saponis. *Synonym.*—Opodeldoc. Soft soap, 80; camphor, 40; oil of rosemary, 15; water, 170; alcohol (90 per cent.), to 1000.

Soft soap is contained in Linimentum Terebinthinæ.
Linimentum Saponis is contained in Linimentum Opii.
For Sapo Animalis *see* p. 661.

Uses.

Hard soap, like curd soap, may be used for medicated soaps. The prescriber should state the percentage of the drug, *e.g.* ichthyol, tar, sulphur, he wishes the soap to contain. The dispenser planes the hard or curd soap into thin shavings, dries them at 38°C., powders them in a mortar, then thoroughly mixes and beats up the soap powder, the drugs, and 1 part of alcohol (60 per cent.) to 8 parts of soap powder. The whole is put into a soap press and stamped.

Hard soap forms a basis for many pills and for the plaster of it. Soft soap is a basis for the liniment of it. Either variety is frequently made into a lather with about a pint of water at 38°C. and used as a purgative enema. Soft soap is much to be preferred; about 1 fl. oz. (30 mils) is commonly used. All enemata, but perhaps especially those made with hard soap, may produce an erythematous rash, probably due to the solution and consequent absorption of some fæcal toxin.

GLYCERIN.

Glycerinum.—Glycerin. $C_3H_5(OH)_3$. *Synonym.*—Glycerol. It is a trihydric alcohol. It is always associated with a little water.

SOURCE.—It is obtained by hydrolysis by the interaction of alkalies or of superheated steam with fats and fixed oils (*see* pp. 4 and 604).

CHARACTERS.—These are well known. It is miscible with water and alcohol. Its sp. gr. is 1·26. It is formed in the making of lead plaster (*see* p. 170).

Dose, 1 to 2 fl. dr.—4 to 8 mils.

Preparations.

1. Glycerinum Acidi Borici. *Synonym.*—Boroglyceride.—Powdered boric acid, 3; glycerin, 10; heat gently. It is a 30 per cent. solution.

2. Glycerinum Acidi Carbolici.—Carbolic acid, 1; glycerin, 5.

3. Glycerinum Acidi Tannici.—Tannic acid, 1; glycerin, 5.

4. Glycerinum Aluminis.—Purified alum, 20; glycerin, 120; distilled water, 7·5; heat gently if necessary.

5. Glycerinum Amyli.—Starch, 2; glycerin, 13; water, 3; heat to form a jelly.

6. Glycerinum Boracis.—Borax, 1; glycerin, 6.

7. Glycerinum Pepsini.—Pepsin, 100; hydrochloric acid, 11·5; glycerin, 600; distilled water to 1000. *Strength*, 1 fl. dr. contains about 5·5 gr. of pepsin; 10 mils contain 1 grm.

Dose, 1 to 2 fl. dr.—4 to 8 mils.

8. Glycerinum Plumbi Subacetatis.—Strong solution of lead acetate, 5; glycerin, 5; water, q.s. Sp. gr. 1·48.

9. Glycerinum Tragacanthæ.—Tragacanth, 1; glycerin, 3; water, 1.

10. Suppositoria Glycerini.—Gelatin, 14; glycerin, 70; water, to make 100; each suppository contains 70 per cent. of glycerin. They must be kept wrapped in waxed paper, as they absorb moisture.

Glycerin is also contained in Linimentum Potassii Iodidi cum Sapone, in Mel Boracis, in all Lamellæ, in Extractum Cinchonæ Liquidum, Pilula Quininæ Sulphatis, Syrupus Pruni Virginianæ, Lotio Hydrargyri Nigra, Liquor Ethyl Nitritis, Tinctura Rhei Composita, Tinctura Cardamomi Composita, Tinctura Kino, Tinctura Chloroformi et Morphinæ Composita, Confectio Sulphuris, and in Unguentum Iodi.

Action.

External.—As glycerin is an excellent solvent for numerous bodies, such as iodine, bromine, alkalies, tannic acid, many neutral salts, alkaloids, and salicin, it is a good vehicle for applying these substances to the skin and to sores. It does not evaporate nor turn rancid, and is powerfully hygroscopic.

Internal.—In man the only visible effect produced by its administration is purging. This occurs with quite small doses if it is given by the rectum, but large doses are necessary if given by the mouth. It is absorbed from the alimentary canal, and is to a slight extent a food, for some of it is oxidized in the body. Sometimes its administration leads to the appearance in the urine of a body which reduces cupric oxide and gives the fermentation test for sugar. There has been much dispute as to whether glycerin can control nitrogenous metabolism, but it appears that it cannot in any way save the waste of nitrogenous tissues. It probably has some influence on the amount of glycogen in the liver. It has also been thought to prevent artificial glycosuria, but this is doubtful.

Very large doses in animals cause the urine to be dark from the presence of the colouring matter of the blood, although there are no corpuscles in it; they also lead to loss of muscular strength, lethargy, dryness of mucous membranes, collapse, and death.

Therapeutics.

External.—Glycerin is much employed as a basis for applications to the skin and the eye. It

is commonly used for chapped hands and slight excoriations. It is readily absorbed when rubbed into the skin, therefore it is a convenient vehicle for the absorption of substances by the skin. Belladonna mixed with glycerin is often rubbed in when we desire its local anodyne action (*see* p. 391).

Internal.—As glycerin is sweet it is an excellent flavouring agent. It is demulcent, and is used as a vehicle for applying substances, such as tannic acid, to the throat. Glycerin is rarely given by the mouth for any medicinal virtue. It has been administered for dyspepsia, for diabetes, and as a nutritive agent, but probably in each case without much good. One to two fluid drachms injected up the rectum, or a glycerin suppository, form an excellent means of opening the bowels in simple constipation, especially when the fæces are in the sigmoid flexure and rectum. The result is prompt, often occurring within less than half an hour. No pain or constitutional disturbance is produced.

OLEIC ACID.

Acidum Oleicum.

SOURCE.—Made by the saponifying action of alkalies and subsequent action of acids, or by the action of superheated steam, upon commercial oleins.

CHARACTERS.—A straw-coloured oily liquid, nearly odourless and tasteless, very faintly acid. By exposure it darkens in colour and becomes rancid. It becomes semi-solid at 40°F. Sp. gr. 0·89 to 0·91. *Solubility.*—Not in water. Easily in alcohol, chloroform, and ether.

IMPURITIES.—It is rarely pure, usually containing stearic and palmitic acids.

Oleic acid is contained in Unguentum Atropinæ, in Unguentum Aconitinæ and Unguentum Cocainæ.

Lead plaster contains oleate of lead, and *Zinc oleate ointment contains* oleate of zinc.

Hydrargyri Oleas is official.

ACTION AND THERAPEUTICS.

Oleic acid is used as a solvent for remedies which it is desired to apply by means of cutaneous inunction, for it more readily penetrates the skin than fats and oils. It is particularly useful as it will dissolve most metallic oxides and all alkaloids (but not their salts), forming oleates dissolved in the excess of oleic acid. Hence its employment in the official preparations mentioned above. Oleate of copper is also used for ringworm and indolent sores. Oleic acid is given internally in capsules ($7\frac{1}{2}$ ♏, 50 centimils, in each) for gallstones. Two or three daily, best on an empty stomach. It acts like olive oil (*see* p. 601).

ALMONDS.

Amygdala Dulcis.—Sweet Almond. *Synonym.*—Jordan almond. The ripe seed of *Prunus amygdalus*, var. *dulcis*.

CHARACTERS.—About $2\frac{1}{2}$ centimetres long; oblong, acute at one end, rounded at the other, flattened; brown, slightly rough exterior. Taste sweet and nutty.

COMPOSITION.—The chief constituents are—(1) *Oleum Amygdalæ* (*see* p. 609), 50 per cent., the same fixed oil as in bitter almonds. (2) Emulsin and other albuminous bodies.

IMPURITY.—The bitter almond, giving an odour of prussic acid when rubbed with water.

Preparations.

1. **Pulvis Amygdalæ Compositus.** — Sweet almonds, 6; sugar, 3; gum acacia, 1.

2. **Mistura Amygdalæ.**—Compound almond powder, 125; water, 1000.

Dose, $\frac{1}{2}$ to 1 fl. oz.—15 to 30 mils.

Amygdala Amara.—Bitter Almond. The ripe seed of *Prunus amygdalus*, var. *amara*.

CHARACTERS.—Like the sweet almond, but broader and shorter, with a bitter taste.

COMPOSITION.—The chief constituents are—(1) *Oleum Amygdalæ* (*see below*), 50 per cent. (2) *Emulsin*. (3) *Amygdalin*, $C_{20}H_{27}NO_{11}$, a crystalline soluble glucoside which,

on mixing with water, is hydrolysed by the enzyme, emulsin, and yields glucose, prussic acid, and *Oleum Amygdalæ Amaræ* (*synonyms*—Essential oil of bitter almonds, benzaldehyde) (not official). Thus $C_{20}H_{27}NO_{11} + 2H_2O = C_6H_5COH$ (the essential oil) + $HCN + 2C_6H_{12}O_6$. The oil itself is not poisonous, and is used to flavour sweets; nitro-benzol used to be often substituted, and has caused death. The essential oil usually has some prussic acid associated with it, and this form may be used for external application, but for internal use the oil without prussic acid should be ordered.

Oleum Amygdalæ.

SOURCE.—The fixed oil obtained by expression from either sweet or bitter almonds.

CHARACTERS.—Pale yellow, nearly inodorous, with an oleaginous, nutty taste. *Solubility.*—Slightly in alcohol, easily in ether or chloroform. Sp. gr. 0·915 to 0·920. It is commonly adulterated with peach-kernel oil.

Almond oil is contained in Linimentum Ammoniæ, Oleum Phosphoratum, and Unguentum Aquæ Rosæ, as it makes a whiter ointment than olive oil.

ACTION AND THERAPEUTICS.

The sweet almond is demulcent. Its most important medicinal use is that it is made into flour to replace starchy food in cases of diabetes. Biscuits are made of the flour. These are very palatable, are a good nutritive food, and contain very little starch. The only objection to them is their price. With a little care they can be made at home. The flour of other nuts, as Brazil nuts, has been used, but it is not nearly so palatable.

The almond mixture is a very pleasant vehicle for the suspension of insoluble substances, and the powder is a palatable basis for powders.

Oleum Amygdalæ might be used for the same purposes as olive oil. It is pleasanter, but very expensive.

TRAGACANTH.

Tragacantha.—A gummy exudation obtained by incision from *Astragalus gummifer* and other species of *Astragalus*. Known in commerce as Syrian Tragacanth. From Asia Minor.

Characters.—In white or yellowish, thin flakes of varying size or shape, marked with concentric ridges, somewhat translucent, tough, but more pulverizable at a temperature of 49° C. Odourless and almost tasteless. Sparingly soluble in cold water, but swells into a gelatinous mass, which is tinged violet (not so deep as the colour given by starch) by tincture of iodine. *Resembling tragacanth.*—Scilla, which is thicker and opaque.

Impurities.—Other gums.

Composition.—The chief constituents are—(1) *Tragacanthin* (said to be identical with Bassorin), a gum, $C_{12}H_{20}O_{10}$, 33 per cent., only slightly soluble in water, unfermentable. (2) An *Arabin*-like gum, 53 per cent., soluble in water, very like the arabin of acacia, but it is precipitated by lead acetate or ferric chloride. (3) A little starch.

Preparations.

1. **Glycerinum Tragacanthæ.**—Tragacanth, 1; glycerin, 3; water, 1.

2. **Mucilago Tragacanthæ.**—Tragacanth, 1·25; alcohol (90 per cent.), 2·5; water, 100.

3. **Pulvis Tragacanthæ Compositus.**—Tragacanth, 15; gum acacia, 20; starch, 20; sugar, 45.
Dose, 10 to 60 gr.—6 to 40 decigrms.

Tragacanth is contained in Confectio Sulphuris, Mistura Cretæ, Mistura Guaiaci, Pilula Ferri, Pilula Hydrargyri Subchloridi Co., Pilula Quininæ Sulphatis, and Pulvis Opii Compositus.

Action and Therapeutics.

Tragacanth is a demulcent, and as such may be soothing when applied to a sore throat. Its chief use is to suspend insoluble bodies, as resins, oils, and insoluble powders. The mucilage is better for this purpose than the compound powder, which, because of its starch, is liable to ferment.

GUM ACACIA.

Acaciæ Gummi.—A gummy exudation from the stem and branches of *Acacia Senegal,* and from other species of *Acacia.* Kordofan. It is one of the varieties of Gum Arabic.

CHARACTERS.—Round or ovoid tears or masses. Colourless, or with a faint yellowish-brown tint. The tears are either opaque from numerous minute fissures and brittle, or they are glistening, transparent, and difficult to break. No odour. Taste bland, mucilaginous. *Solubility.*—Freely in water, not in alcohol.

COMPOSITION.—The chief constituent is *arabin,* or *arabic acid,* $C_6H_{10}O_5$; most of it is combined with calcium, but some with magnesium and potassium.

IMPURITIES.—Starch, gum-resins.

INCOMPATIBLES.—Alcohol, sulphuric acid, borax, per-salts of iron, and lead subacetate.

Preparation.

Mucilago Acaciæ.—Gum acacia, 10; water, 15. Should be recently prepared.

ACTION AND THERAPEUTICS.

Gum acacia is demulcent. It is used to suspend insoluble substances, as oils, resins, and insoluble powders. A fluid ounce of most oils or resinous tinctures requires 3 fl. dr. (12 mils) of mucilage of acacia for suspension, but copaiba requires 10 fl. dr. (40 mils). A disadvantage of it is that it is liable to undergo acetous fermentation, which greatly diminishes its emulsifying power. This may to some extent be overcome by making it with tolu water or clove water. It may give rise to indigestion and diarrhœa.

A filtered sterilized 6 per cent. solution of gum acacia in 0·9 per cent. sodium chloride solution is strongly recommended by Bayliss for intravenous injection in wound shock. It is most useful in cases of hæmorrhage and produces neither hæmolysis, agglutination or anaphylaxis. It has a viscosity and

colloidal osmotic pressure equal to that of blood and does not therefore leave the blood vessels.

INDIAN GUM.

Gummi Indicum.—A gummy exudation from the wood of *Anogeissus latifolia.*

Characters.—Rounded pale amber translucent tears.

Preparation.

Mucilago Gummi Indici.—Indian Gum, 1; water, 15.

Action and Therapeutics.

Indian gum is used in India and the East Indies for the same purposes as gum acacia.

LIQUORICE.

Glycyrrhizæ Radix.—Liquorice Root. The peeled root and peeled subterranean stems of *Glycyrrhiza glabra* and other species. Cultivated in Britain.

Characters.—Long cylindrical pieces; before being peeled dark brown and longitudinally wrinkled, when peeled yellow, fibrous. Fracture fibrous. Faint odour. When fresh, taste sweet and mucilaginous, slightly acid when dried. *Resembling liquorice.*—Pyrethrum and Taraxacum, which are not sweet.

Composition.—The chief constituents are—(1) *Glycyrrhizin*, a yellow amorphous glucoside, $C_{24}H_{36}O_9$, probably in combination with ammonia. With acids this yields a very bitter substance, glycyrrhetin, and glucose. (2) Asparagin. (3) Grape sugar, resin, starch, gum, and malic acid.

Preparations.

1. **Extractum Glycyrrhizæ.**—Liquorice root, 1; chloroform water, 5.

2. **Extractum Glycyrrhizæ Liquidum.**—Liquorice root, 1; chloroform water, 5; alcohol (90 per cent.), q.s.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

3. **Pulvis Glycyrrhizæ Compositus.**—Senna, 16; liquorice root, 16; fennel, 8; sublimed sulphur, 8; sugar, 52.

Dose, 60 to 120 gr.—4 to 8 grms.

Liquorice or its preparations are contained in many preparations, generally to cover their nauseous taste. They hide very well that of aloes, cascara sagrada, ammonium chloride, hyoscyamus, senega, senna, turpentine, and very bitter substances.

ACTION AND THERAPEUTICS.

Liquorice is an excellent demulcent for sore throats. It is used to hide the taste of nasty medicines, and as a basis for pills. The compound liquorice powder is laxative in virtue of its senna and sulphur.

LINSEED.

Lini Semina.—Linseed (called Linum B. P. 1898). The dried ripe seeds of *Linum usitatissimum*, flax. Cultivated in Britain.

CHARACTERS.—Small, flat, oval, pointed, with acute edges; brown, smooth, shining externally, yellowish white within; odourless; testa mucilaginous.

COMPOSITION.—The covering contains much mucilage. The interior contains 30 per cent. of the fixed oil (*see below*).

Lini Semina Contusa.—Crushed Linseed (called Linum Contusum B. P. 1898). *Synonym.*—Linseed meal. Linseed reduced to powder. It should be recently prepared.

Oleum Lini.—Linseed Oil.

SOURCE.—Expressed from linseed.

CHARACTERS.—It is viscid, yellow fixed oil, of sp. gr. 0·930 to 0·940. It is commonly called "drying oil" because it unites with oxygen and becomes resinoid on exposure, the linoleic acid in it becoming oxylinoleic acid.

COMPOSITION.—It consists of a compound of glyceryl with linoleic acid together with small quantities of palmitin and myristin.

ACTION AND THERAPEUTICS.

A linseed poultice (mix gradually 4 parts of crushed linseed with 10 of boiling water, stirring all the while. Do it before the fire, and heat the basin first so that the poultice may be as warm as possible)

is a very common means of applying warmth and moisture to a part. It is used to relieve pain, and as a mild irritant to accelerate inflammation and the bursting of an abscess, or as a counter-irritant in all sorts of deep-seated inflammations. The poultices should not be too thick, and should be smeared with oil to prevent their sticking to the skin. The vascular dilatation caused by a linseed poultice may be increased by adding 1 part of mustard to 16 of linseed. A layer of linseed meal may be placed on the powdered ice of an ice poultice (*see* p. 126), to absorb the water and to prevent the lumps of ice from hurting the skin. The ice poultice may be made in between sheets of thin gutta-percha, and the edges stuck together by being moistened with chloroform.

Linseed oil is applied to burns. Mixed with an equal quantity of lime water it forms carron oil, which is a substitute for Linimentum Calcis.

Linseed tea (linseed, 150 gr., 10 grms.; liquorice, 50 gr., 3 grms.; boiling water, 10 fl. oz., 300 mils; infuse for two hours) is a common domestic demulcent; the large quantity of mucilage it contains forms a coating for the pharynx and mouth, and thus relieves cough due to sore throat. It is said to be slightly diuretic.

SPOGEL SEEDS.

Ispaghula. *Synonym.*—Spogel Seeds. The dried seeds of *Plantago ovata.*

Characters.—Boat-shaped, about 2 to 3 millimetres long and half as wide. Pale greyish-brown, with a dark spot on the convex side.

Dose, 45 to 150 gr.—3 to 10 grms.—in powder.

Preparation.

Decoctum Ispaghulæ.—15 grms. of seeds to 1000 millilitres of water.

Dose, $\frac{1}{2}$ to 2 fl. oz.—15 to 60 mils.

Action and Therapeutics.

These seeds contain much mucilage, and are used in India and the East for the same purposes as linseed. For use externally a poultice may be made from them, and internally the decoction is an excellent demulcent for sore throat, and is often given as a cool demulcent drink in diarrhœa. It is frequently given to children.

SUGAR.

Saccharum Purificatum.—Refined Sugar. *Synonyms.*—Cane sugar, Sucrose. $C_{12}H_{22}O_{11}$.

Preparations.

1. **Syrupus.**—Refined sugar, 10; dissolved in water, 15, with the aid of heat. Sp. gr. 1·330.
2. **Syrupus Glucosi.**—Syrup, 2; glucose, 1.

Action and Therapeutics.

Sugar is used as a sweetening agent, and in Liquor Calcis Saccharatus it increases the solubility of the lime. Syrupus Glucosi is used in pharmacy, especially in the making of pills, as it forms a neutral basis.

GLUCOSE.

Glucosum.—Glucose is a mixture of dextrose, $C_6H_{12}O_6$, and other analogous substances, and is obtained by the hydrolysis of starch.

Characters.—A very viscous syrup, almost colourless. No odour. Taste sweet. Freely soluble in water.

Preparation.

Syrupus Glucosi.—Glucose, 1; syrup, 2.

Action and Therapeutics.

Tubes containing such an amount of glucose that, when added to a pint of sterilized water, a 6 per cent. (isotonic with the blood) solution is formed, are sold. Such a solution, transfused into the subcutaneous tissue, may be used for artificial feeding as a preliminary to and after severe operations (*see also* p. 602). Sugar is better absorbed from the rectum than any other food. The best method of

rectal feeding is to give 6 per cent. dextrose solution in tap water (525 grains to 1 pint) every six hours. If the patient can at each injection retain as much as 15 fl. oz., this equals 27 grm. dextrose, which is 440 calories a day. Sometimes stronger solutions may be tolerated but usually anything above the 6 per cent. isotonic solution is not retained easily. It is a common error to give the dextrose in normal saline, this is absorbed with difficulty, being hypertonic. Dextrose, alternated with bicarbonate of soda, by the rectum, is the best treatment for acidosis not due to diabetes.

Lævulose.—(Not official.) $C_6H_{12}O_6$. Sufferers from diabetes can sometimes take this without harm when they cannot tolerate any other carbohydrate.

Malt.—(Not official.) *Synonym.*—Byne. The seed of common barley, *Hordeum distichum*, caused to enter the incipient stage of germination by heat and then dried. It contains the ferment diastase, which can convert starch into dextrin and finally to maltose. Thus $(C_6H_{10}O_5)_{2n}$ starch $+ nH_2O = nC_{12}H_{22}O_{11}$ maltose.

Extractum Malti.—Extract of Malt. (Not official.) *Synonyms.*—Extractum Bynes, Maltine. A liquid of the density of honey.

Source.—It is prepared in many ways from malt, but the basis of them all is that malt is macerated with water at about 52°C. to 72°C., and evaporated to the consistency of a thick extract. Sometimes cold water is added and the mixture is heated to between 52° and 72°C., or the warm water may be added at once. The maceration lasts several hours. Sometimes the extract is then boiled to destroy the diastasic ferment, for then it keeps better, but it loses a valuable constituent. Manufacturers often mix flour with the malt. The evaporation may be conducted *in vacuo*, and in some specimens the maltose has undergone some alcoholic fermentation; any quantity from a trace to 10 per cent. of alcohol may be present.

Composition.—This varies very much. The chief constituent is *maltose*, $C_{12}H_{22}O_{11}$; there is also some dextrin, $(C_6H_{10}O_5)n$, some diastase (unless destroyed by boiling), albumens, the salts of barley, and sometimes alcohol.

Characters.—A sweet, thick, brownish liquid, like honey. Good specimens can by their diastase convert starch into maltose. It forms an emulsion with oils.

Dose, 1 to 4 fl. dr.—4 to 15 mils.

Action and Therapeutics.

Maltose is a very valuable food, especially for persons who are suffering from wasting diseases, and have a feeble digestion. It is easily tolerated by the stomach, even when, as is often the case in phthisis, other food, especially cod-liver oil, is rejected. In such a case a malt extract is an excellent substitute for cod-liver oil. Maltose leads to the formation of fat, and, like any carbohydrate, saves the protein tissues in fever. The fevered patient may take as much maltine as he can without upsetting his digestion. The diastase contained in malt extract acting upon the starch in farinaceous food converts it into dextrin and maltose, and thus, if the secretion of saliva and pancreatic juice is feeble, the extract to some extent supplies their place. Like the ferments in pancreatic juice and saliva, diastase can only act in an alkaline medium, and therefore extract of malt should not be given till at least two hours after a meal. Emulsions of cod-liver oil in it are frequently useful. Bynol is an example of these. They should contain 20 per cent. of cod-liver oil to 80 per cent. of maltine. A mixture of extract of malt and iron is also valuable (iron pyrophosphate, 2 parts; water, 3 parts; dissolve and add extract of malt, 95 parts. Mix. Dose, 1 to 4 fl. dr., 4 to 15 mils). This is Extractum Malti Ferratum, B. P. C., and there are in the market numerous preparations of extract of malt with formates, glycerophosphates, hypophosphites, quinine, strychnine, and pepsin.

Soya Beans.—(Not official.)

The beans of *Soya hispida*. These are powdered and made into a flour, from which bread and biscuits are prepared. The flour contains much fat but very little starch or sugar, sometimes not more than 2 or 4 per cent.

Bread and biscuits made from the flour are used in the treatment of diabetes as a substitute for gluten bread; they are sometimes as efficacious in reducing the sugar passed in the urine, and many patients prefer the taste.

GROUP X.

Vegetable Drugs used to destroy Parasites.

Class I.—*Anthelmintics* for the various species of *Tapeworm.*

Male Fern, Pelletierine Tannate, Cusso, Melon Pumpkin Seeds, Embelia.

Class II.—*Anthelmintics* for the *Roundworm* (*Ascaris lumbricoides*).

Santonin, Butea Seeds.

Class III.—*Anthelmintics* for the *Threadworm* (*Oxyuris vermicularis*). These are described under the head of bitters (*see* page 578).

Class IV.—*Anthelmintics* for *Hookworms* (*Ankylostoma duodenale and Necator americanus*). **Thymol** (*see* page 643).

Class V.—*Parasiticide* used for pediculi.

Stavesacre.

Class I.—Anthelmintics used for Tapeworms.

MALE FERN.

Filix Mas.—Male Fern. The rhizome of *Dryopteris Filix-mas*, collected late in autumn; divested of its leaves, roots, and all dead portions, and carefully dried. Should not be kept more than one year.

Characters.—7 to 15 centimetres or more long. The rhizome about 2 centimetres in diameter, entirely covered by the curved, angular, dark brown bases of the petioles which bear membranous scales; brown externally, yellowish white or brownish within. Odour feeble, disagreeable. Taste sweetish and astringent at first, subsequently bitter and nauseous.

Composition.—The chief constituents are—(1) *Filicin*, an amorphous body, which on exposure to air becomes crystalline, probably the active principle. (2) Aspidinin. (3) Resins.

Preparation.

Extractum Filicis Liquidum. *Synonym.*—Oil of male fern. Male fern is percolated with ether, which is then evaporated, and an oily liquid is left, which is really an oleoresin.

Must contain not less than 20 grms. of filicin in 100 grms. of the liquid extract.

Dose, 45 to 90 m.—3 to 6 mils—in an emulsion with mucilage of acacia or tragacanth, or with milk, as water precipitates the resin.

Action and Therapeutics.

Male fern is the most certain **anthelmintic** we have for the common **tapeworm** and the bothriocephalus latus. The pharmacopœial dose of the extract is small, and 2 or 3 fl. dr. (8 to 12 mils) are often used, flavoured with ginger or peppermint. The intestine being emptied with a mild purge to ensure the worm not being protected by food, the male fern should be administered, and in twelve hours another dose of the purgative should be given to clear away the worm. It is well not to use castor oil, for filicic acid, which is believed to cause the toxic symptoms mentioned below, being soluble in this, may be absorbed. Very little food should be taken during the treatment, and the head of the worm should be carefully searched for in the motion.

Probably the male fern only paralyses the worm, which cannot then maintain its place in the gut and is swept away by the second purge.

The extract kills the *Ankylostoma duodenale*, but is not so efficacious as thymol.

Toxic doses are severe gastro-intestinal irritants, and also cause muscular weakness, coma, and optic atrophy.

PELLETIERINE TANNATE.

Pelletierinæ Tannas. — A mixture of the alkaloids obtained from the bark of the root and stem of Punica Granatum.

Characters.—A light yellow amorphous powder, slightly soluble in water, more in alcohol.

Dose, 2 to 8 gr.—12 to 50 centigrms.

Action and Therapeutics.

It has a specific action on the tapeworm. This parasite immersed in a 1 in 10000 solution for ten minutes dies. The requisite dose may be administered in solution; being very insoluble, it passes unchanged in the stomach, and by the time it reaches the intestine enough of it is dissolved to kill the tapeworm. It should be followed after two hours by a purge, and should be given on an empty stomach.

CUSSO.

Cusso. *Synonym.*—Kousso. The dried panicles of pistillate flowers of *Brayera anthelmintica*. Abyssinia.

Characters.—In compact clusters or rolls, 3 to 6 decimetres long. Odour tea-like. Taste bitter. Separate panicles, branched, zigzag, with hairs and glands on them, and a large bract at the base of each branch. Flowers numerous, small, shortly stalked, unisexual. Two bracts at the base of each flower. Calyx hairy, veiny; five segments on each of two alternating whorls.

Composition.—The chief constituents are—(1) Koussin, or Koussotoxin, a neutral active principle soluble in alkalies. (2) Oil, gum, tannic acid, and resin.

Dose, 120 to 240 gr.—8 to 16 grms.

Action and Therapeutics.

Cusso is rarely given in England, but is used abroad as an anthelmintic for all species of tapeworm. It is best given as an infusion, which is drunk without straining.

MELON PUMPKIN SEEDS.

Cucurbitæ Semina Præparata. Melon Pumpkin Seeds. *Synonym.*—Pepo. The prepared fresh ripe seeds of cultivated plants of *Cucurbita maxima*.

Characters.—Flat, ovate, white, consisting of two fleshy, easily separable, cotyledons, which have been freshly deprived of the yellowish outer and brownish inner integument.

Dose, 3 to 4 oz.—about 100 grms.—bruised with a little water or milk to a creamy consistence. When used the seeds must not be more than one month old.

Action and Therapeutics.

These seeds are an efficient anthelmintic for the tapeworm. The patient should have a light supper of bread and milk; in the early morning he should take the above dose of seeds; a cup of tea or coffee an hour later, but no food; at 10 A.M. a good dose of castor oil or some other simple purge; and two hours later a substantial meal. They are used chiefly in the Mediterranean colonies.

EMBELIA.

Embelia.—The dried fruit of *Embelia ribes* and of *Embelia robusta.*

Characters.—Globular, 4 millimetres in diameter, dull red, with dark spots; contains a horny reddish seed.

Dose, 60 to 240 gr.—4 to 16 grms.

Action and Therapeutics.

These berries powdered, or an infusion made from them, form an excellent anthelmintic for tapeworm. The taste is not unpleasant, and the general directions are the same as those given for administering melon pumpkin seeds. Chiefly used in India and the East.

Class II. **Anthelmintics used for Roundworm.**

Santonin, Butea Seeds.

SANTONIN.

Santoninum.—Santonin, $C_{15}H_{18}O_3$. A neutral crystalline principle obtained from santonica, the dried unexpanded flower heads or capitula of *Artemisia maritima*, var. *Stechmanniana.*

Characters.—Colourless, flat, glittering, rhombic prisms, turning yellow on exposure to light. Tasteless or feebly bitter. *Solubility.*—Not at all in mineral acids, feebly in cold water, easily in chloroform. It forms santonates with alkalies.

Dose, 1 to 3 gr.—6 to 20 centigrms.

Preparation.

Trochiscus Santonini.—0·06 grm. or 1 gr. in each with a simple basis.

Action.

Santonin is commonly said to be anthelmintic, killing the roundworm, *Ascaris lumbricoides*, but as, outside the body, but at the body temperature, it does not kill this worm, it is supposed that it gets rid of the parasite by in some way compelling it to pass into the large intestine, from which it is expelled by the purge usually given. It has little or no action against other intestinal parasites. Some of the santonin is absorbed as sodium santonate. Medicinal doses will usually cause the urine, if it is acid, to be a greenish-yellow or saffron colour, and if it is alkaline to be purplish red. This is due to the excretion in that fluid of some substance resulting from the changes undergone by santonin in the body. It is slightly diuretic. Often even small doses lead to xanthopsy—that is to say, everything the patient sees has a yellow tint; this is not the result of the staining of the tissues of the eye yellow, but is a direct effect on some other part of the visual path. Sometimes the yellow vision is preceded by violet vision.

Several cases of fatal poisoning by santonin are on record. Cerebral symptoms are very prominent. Thus convulsions, accompanied by unconsciousness, trismus, and dilated pupils, are generally present. The surface becomes cold, there is sweating, there may be trembling, the pulse and respiration become weaker and weaker, and death takes place from cardiac and respiratory failure.

Therapeutics.

Santonin is used solely to get rid of intestinal worms. The dose of it should be given on an empty

stomach, and should be followed in two hours by a purgative, such as calomel. Santonin is certainly very efficacious for the *Ascaris lumbricoides*. The lozenge is not to be recommended, for it may not dissolve, and then will probably fail to kill the worm. A good way to give santonin is to suspend it and castor oil in mucilage flavoured with peppermint. As already mentioned, probably it has no effect on the *Oxyuris vermicularis* when given by the mouth, but a suppository made with oil of theobroma, and containing 4 grains (25 centigrms.) of santonin, is said to kill this parasite.

BUTEA SEEDS.

Buteæ Semina.—The seeds of *Butea frondosa*.

CHARACTERS.—Flat, reniform, about 30 mm. long, 20 mm. wide, and $1\frac{1}{2}$ mm. thick. Skin glossy, dark reddish brown.

Preparation.

Pulvis Buteæ Seminum.—Soak Butea seeds in distilled water; carefully remove the integuments; dry and powder the kernels.

Dose, 10 to 20 gr.—6 to 12 decigrms.

ACTION AND THERAPEUTICS.

Externally a paste made from these seeds has been used for ringworm. Internally the powder is given as a laxative and anthelmintic for roundworms, in place of santonin. A dose of 20 grains a day for three successive days usually suffices.

CLASS V.—**Parasiticide used for Pediculi.**

STAVESACRE.

Staphisagriæ Semina.—Stavesacre Seeds. The dried ripe seeds of *Delphinium staphisagria*.

CHARACTERS.—Irregularly triangular or obscurely quadrangular, arched, blackish brown when fresh, but becoming dull greyish brown by keeping. Testa wrinkled and deeply

pitted, nucleus soft, whitish and oily. No marked odour. Taste nauseous, bitter and acrid.

COMPOSITION.—The chief constituents are—(1) A fixed oil. (2) A very poisonous alkaloid, *delphine*, acting like aconitine. (3) Other alkaloids.

Preparation.

Unguentum Staphisagriæ.—Crushed seeds, 20; yellow beeswax, 10; benzoated lard, 85.

In India benzoated suet should be used instead of benzoated lard.

ACTION AND THERAPEUTICS.

Stavesacre is only used as a parasiticide to kill pediculi. The affected part is rubbed with the ointment, which in the case of pediculi vestimentorum is allowed to soak, day and night, into the garments next to the skin, for the parasite inhabits them. It is often employed, but it will be remembered that many other parasiticides for pediculi have been mentioned (*see* p. 48).

GROUP XI.

Vegetable Drugs apparently having chiefly a Diuretic Action.

Uva Ursi, Scoparium, Couch Grass.

UVA URSI.

Uvæ Ursi Folia. *Synonyms.*—Bearberry leaves. The dried leaves of *Arctostaphylos uva-ursi*. Britain.

CHARACTERS.—Very shortly stalked, yellowish green, obovate or spathulate, coriaceous, about 2 centimetres long. Upper surface smooth and shining; under paler, minutely reticulated. Taste very astringent. *Resembling Uva Ursi.*—Senna (*see* p. 503) and buchu (*see* p. 572).

COMPOSITION.—The chief constituents are—(1) *Arbutin*, $C_{24}H_{32}O_{14}$, a bitter crystalline glucoside yielding glucose, hydroquinone, and methyl-hydroquinone. (2) Ericolin, a

bitter crystalline glucoside. (3) Urson, a tasteless neutral body. (4) Tannic and gallic acids, 33 per cent.

Incompatibles.—Iron, lead and silver salts, alkaloids, and gelatin.

Preparation.

Infusum Uvæ Ursi.—1 in 20 of boiling water.
Dose, ½ to 1 fl. oz.—15 to 30 mils.

Action.

Uva Ursi is a well-marked diuretic, and is astringent and disinfectant to the urinary mucous membrane. Its disinfectant action is probably due to the decomposition of the arbutin into glucose and hydroquinone, for after Uva Ursi is given hydroquinone is found in the urine, and it is a very energetic antiseptic. This decomposition must take place in the kidneys, for hydroquinone is a powerful poison. Against this being the reason of the disinfectant action of Uva Ursi, it is urged that giving arbutin does not disinfect the urine; but others deny this, and believe that arbutin itself is a urinary antiseptic and a diuretic. The urine may be a pale greenish to dark greenish-brown colour. Hydroquinone is also found in the urine in carbolic acid poisoning (*see* p. 338). The astringent action of Uva Ursi on the urinary tract is usually ascribed to the gallic and tannic acids, but as these are not remote astringents this is most likely wrong.

Therapeutics.

Uva Ursi is given to disinfect the urine in the same class of cases as buchu—that is to say, in pyelitis, cystitis, and gonorrhœa.

BROOM.

Scoparii Cacumina.—Broom Tops. The fresh and dried tops of *Cytisus scoparius*. Indigenous.

Characters.—The stem is dark green, with long, straight, alternate branches. The latter, like the stem, are winged,

tough and flexible. Occasionally with leaves attached. These are small, sessile and simple above, stalked and trifoliate below. Taste bitter and nauseous. When bruised gives a peculiar odour if fresh.

COMPOSITION.—The chief constituents are—(1) *Scoparin*, $C_{21}H_{22}O_{10}$, a yellow, crystalline, neutral principle, which is diuretic. (2) *Sparteine*, $C_{15}H_{26}N_2$, an oily, liquid, volatile alkaloid; it also is said to be diuretic.

Preparations.

1. **Infusum Scoparii.**—*Dried* broom tops 1; boiling water, 10.
Dose, 1 to 2 fl. oz.—30 to 60 mils.

2. **Succus Scoparii.**—Juice of the *fresh* broom tops, 3; alcohol (90 per cent.), 1.
Dose, 1 to 2 fl. dr.—4 to 8 mils.

ACTION.

Broom has no external action, and very little beyond the fact that it is diuretic is known about its internal action. Sparteine was formerly thought to act on the heart like digitalis, but this is erroneous. It paralyses peripheral nerve-endings like coniine. Scoparin is the chief diuretic principle of broom, acting directly on the renal epithelium.

THERAPEUTICS.

Broom is a very useful diuretic. It is usually given in combination with other diuretics in cases of dropsy from heart disease or interstitial nephritis. If there is acute renal inflammation it should not be prescribed. Sparteine has been tried (best given as the sulphate, dose 1 to 4 gr., 6 to 25 centigrms.) in mitral disease, but its use is not justifiable.

COUCH GRASS.

Agropyrum. *Synonym.*—Triticum. The dried rhizome of *Agropyrum repens* freed from leaves and rootlets.

Characters.—Pale yellow, from 2 to 2½ mm. in diameter, usually in sections 3 to 6 mm. long. Strongly furrowed longitudinally, hollow except at nodes. No odour. Slightly sweet.

Preparations.

1. Decoctum Agropyri.—1 in 20.

Dose, ½ to 2 fl. oz.—15 to 60 mils.

2. Extractum Agropyri Liquidum.—Digest couch grass with boiling water and add alcohol (90 per cent.).

Dose, 1 to 2 fl. dr.—4 to 8 mils.

Action and Therapeutics.

It is demulcent, and perhaps slightly diuretic. By many, couch grass is much given as a urinary sedative in cystitis and gonorrhœa. The pharmacopœial dose is frequently exceeded. It is used chiefly in Australian Colonies, Eastern Colonies, and North American Colonies.

GROUP XII.

Vegetable Drugs acting locally on the Uterus.

Ergot, Hydrastis, Cotton Root Bark, Viburnum.

ERGOT.

Ergota.—Ergot. The sclerotium (compact mycelium or spawn) of *Claviceps purpurea*, originating in the ovary of *Secale cereale*, the common rye. It should be thoroughly dried and kept in air-tight containers and should not be used if more than one year old.

Ergot is no part of the rye grain, which completely disappears as the ergot develops.

Characters.—Subcylindrical, tapering at both ends, curved, 1½ to 4 centimetres long. Longitudinally furrowed on both sides, especially the concave, often cracked. Dark violet-purple without, pinkish white within. Fracture short. Odour peculiar, disagreeable. Taste mawkish, rancid.

Composition.—The chief constituents are—(1) *Ergotoxin*, $C_{35}H_{41}O_6N_5$, an amorphous alkaloid forming a crystalline phosphate. It is physiologically very active and is the cause of the activity of the impure bodies called sphacelinic acid and sphacelotoxin. (2) *Ergotinine*,

$C_{35}H_{39}O_5N_5$, is the anhydride of ergotoxin. It is inert physiologically. (3) *Tyramine* or parahydroxyphenylethylamine, $OH{\cdot}C_6H_4\ CH_2\ CH_2\ NH_2$. This has a powerful physiological action resembling that of adrenalin. It may also be obtained from putrid meat and from tyrosine by loss of CO_2 caused by bacteria. (4) *Isoamylamine*, $(CH_3)_2\ CHCH_2CH_2NH_2$. It exists in such small quantities in ergot that it does not affect its physiological action. It occurs in putrid meat and may be derived from leucine by the loss of CO_2. (5) *β-iminazolylethylamine*, $\begin{array}{lll} CH = N & \diagdown & \\ \vert & & C{\cdot}CH_2CH_2NH_2 \\ NH - CH & /\!\!/ & \end{array}$. This, also known as histamine or ergamine, is also formed from histidine by bacterial removal of CO_2 and is present in extracts of intestinal mucous membrane. It has a powerful physiological action. (6) Fixed oil, 30 per cent. (7) Trimethylamine, causing the odour. (8) Tannin. (9) Saponin.

Dose, 15 to 60 gr.—1 to 4 grms.

Preparations.

1. Extractum Ergotæ.—*Synonym.*—Ergotin. Macerate ergot, 100; with water, 750; evaporate, add alcohol (90 per cent.), 65; and evaporate to a soft extract.

Dose, 2 to 8 gr.—12 to 50 centigrms.

2. Injectio Ergotæ Hypodermica.—Extract of ergot, 33; distilled water, 100; carbolic acid, 1, to preserve it. *Strength.*—33 per cent. of the extract.

Dose, 5 to 10 m.—3 to 6 decimils—hypodermically. It should be recently prepared.

3. Extractum Ergotæ Liquidum.—Ergot, 1000; extracted with water, 7500; and alcohol (90 per cent.), 375.

Dose, 10 to 30 m.—6 to 18 decimils.

4. Infusum Ergotæ.—1 in 20 of boiling water.

Dose, 1 to 2 fl. oz.—30 to 60 mils.

5. Tinctura Ergotæ Ammoniata. — Ergot, powdered, 5; solution of ammonia, 2; alcohol (60 per cent.), to make 20. Percolate.

Dose, ½ to 1 fl. dr.—2 to 4 mils—or less if very frequently repeated.

This tincture is ammoniated, as ammonia is said to be the best solvent for the active principles of ergot.

As the solubility and stability of the constituents vary, many believe it is best to give the powdered drug.

Action.

Ergotoxin has been shown by Dale to be the most powerful ingredient of ergot. It acts on the myoneural junctions of the uterus, causing powerful contraction and even abortion in some pregnant animals, *e.g.* the cat. By similar action it contracts the pupil, the bladder, and the arterioles, thus causing a considerable rise of blood-pressure and gangrene of the comb in fowls. Tyramine, and to a less extent isoamylamine, have the same action as adrenalin.

Iminazolylethylamine stimulates the muscle of the uterus directly, and in some animals that of the bronchioles. In a similar manner it contracts most arterioles. The heart is slightly stimulated. The salivary glands are excited, and vomiting and purging occur. These ingredients of ergot are rarely given separately, and the following account refers to the action of ergot itself, but this differs much in different animals.

External.—None.

Internal. — *Gastro-intestinal tract.* — The unstriped muscle of the intestine is stimulated by ergot, and this leads to increased peristaltic movements, but rarely strong enough to cause relaxation of the bowels. The vessels of the intestine are constricted, in part because of the contraction of their own muscular fibres, and in part because of the contraction of those of the intestinal muscular coat. The result is that the intestine is blanched.

Blood.—The active principles of ergot are readily absorbed, but they are not known to produce any effect on the blood.

Heart.—The heart muscle is directly excited by ergot, and because of this and the vascular constriction the blood-pressure rises.

Vessels.—Occasionally there is a preliminary fall of blood-pressure, said by Dixon to be due to im-

purities, but this is soon followed by a great rise, and this is chiefly due to the general contraction of the arteries all over the body; they can, in some parts, be seen to become smaller, especially in the splanchnic area. This vascular contraction is slightly less if the spinal cord is destroyed, from which it is fair to infer that it is partly due to the action of ergot on the vaso-motor centres in the cord, but the drug acts chiefly directly on the muscular coat of the vessels or the termination of the nerves in the muscles, exactly as does adrenalin. The pulmonary arterioles are not constricted. If the ergot be taken for a long time, the contraction of the arterioles, together with the associated thickening of their walls produced by the ergotoxin, leads to gangrene of various parts of the body, and this was a prominent symptom of ergotism (chronic poisoning by ergot) which used to be seen in the very poor who could get no better food than rye infested with *Claviceps purpurea*. Enormous single doses of ergot appear to paralyse the vaso-motor centres, and then the blood-pressure falls from vascular dilatation and cardiac depression.

Nervous system.—Medicinal doses, or even an enormous single dose, very rarely affect the nervous system, but if ergot be taken for a long time, a peculiar train of symptoms sets in; they constituted the second variety of chronic ergotism in the days when diseased bread was eaten. The sufferer first complained of itching and tingling, and a sensation of insects running over the skin; this was followed by numbness and local anæsthesia. These symptoms first appeared in the hands and feet, but spread over the whole body. They were followed by tonic contractions of various muscles, especially those of the extremities. The muscular power was lessened, and the gait was staggering. Dimness of vision, loss of hearing, and epileptiform convulsions were sometimes present. This variety of ergotism was usually

accompanied by vomiting and diarrhœa. Death occurred from asphyxia, due to spasm and weakness of the respiratory muscles. The fact that there are two such distinct varieties of ergotism shows that ergot has an inconstant composition.

Uterus.—Ergot powerfully excites the pregnant uterus of women and the lower animals to contract and expel its contents. It is therefore called an ecbolic. It has very little power in human beings to cause contraction of the unimpregnated uterus.

The flow of urine, of saliva, of sweat, and of milk are slightly diminished by ergot, probably because of the general vascular constriction.

Therapeutics.

The chief use of ergot is to cause efficient contraction of the uterus after labour, and so to diminish the risk of post-partum hæmorrhage. If there is any likelihood of profuse bleeding it should be given subcutaneously, so that it may act rapidly.

Ergot should be administered cautiously before the child is expelled, for the contractions produced by it not only gradually become more severe, but more prolonged, so that ultimately the uterus remains tightly contracted for several minutes; this is, of course, dangerous to the life of the child, and, if the resistance be very great, may lead to rupture of the uterus.

This drug has often been given as a hæmostatic in hæmoptysis and other hæmorrhages from different parts of the body. But it may, by the general rise of blood-pressure, do more harm than good, especially in hæmoptysis, as the pulmonary arteries are not constricted by ergot, and it should not be used as a hæmostatic. In therapeutic doses it only acts on the pregnant uterus.

It has been used to check the night sweats of phthisis, and as an antigalactogogue.

It is often desirable to combine the liquid extract of ergot with perchloride of iron. Because of the tannin in the ergot an inky mixture results, but this may be clarified by the addition of a little citric acid, and the taste may be covered with chloroform water.

Ernutin.—This is fluid containing the active principles of ergot; 5 to 10 minims (30 to 60 centimils) may be given subcutaneously or 30 to 60 minims (2 to 4 mils) by the mouth.

HYDRASTIS.

Hydrastis Rhizoma.—Hydrastis Rhizome. The dried rhizome and roots of *Hydrastis canadensis*, the golden seal, yellow-root, or yellow puccoon. Grows in the Alleghanies.

CHARACTERS.—Rhizome is 10 to 40 millimetres long, 3 to 10 millimetres thick; irregular twisted appearance. Scars of decayed stems on the upper surface. Yellowish brown with short fracture. Interior yellow. Taste very bitter.

COMPOSITION.—It contains—(1) Hydrastine, an alkaloid, $C_{21}H_{21}NO_6$. White prismatic crystals, insoluble in water. **Dose, $\frac{1}{2}$ to 1 gr.—3 to 6 centigrms.**—in a pill. (2) Canadine, (3) Berberine, an alkaloid.

Preparations.

1. Extractum Hydrastis Liquidum.—Powdered hydrastis rhizome, exhausted by percolation with alcohol (60 per cent.).

This liquid extract contains 2 per cent. of hydrastine.

Dose, 5 to 15 m.—3 to 10 decimils.

2. Tinctura Hydrastis.—Liquid extract of hydrastic rhizome, 1; alcohol (60 per cent.), 10. Mix.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

The Hydrochloride of Hydrastinine, an oxidation product of hydrastine, is often used. It exists as pale yellow crystals, soluble 1 in 1 of water.

Dose, $\frac{1}{4}$ to 1 gr.—15 to 60 milligrms.—hypodermically.

Action.

Hydrastis in small doses, because of its berberine, is a gastric bitter, stimulating the appetite, the gastro-intestinal secretions, and peristalsis It is stated, probably incorrectly, to increase the flow of bile. Moderate doses stimulate the medullary centres, thus breathing is quicker and deeper, the heart is slowed, the arterioles are contracted, and blood-pressure rises. Large doses depress the centres, the pulse becomes rapid, blood-pressure falls, and the patient dies from paralysis of respiration. It produces convulsions similar to those of strychnine. In the lower animals it stimulates unstriped muscle and is said to increase uterine contractions and produce abortion, but this is doubtful. Its action is mainly due to the alkaloid hydrastine. It has been stated that this, before it acts, is oxidized into hydrastinine, but against this is the fact that it is excreted unchanged in the urine.

Hydrastinine, like hydrastine, contracts arterioles and raises the blood-pressure. It slows but does not depress the heart. It causes contraction of the uterus by direct action on its muscle, and because of this action and that on arterioles it is used to arrest uterine hæmorrhage.

Therapeutics.

External.—Hydrastis is employed empirically as a local stimulating application in chronic inflammations, such as unhealthy ulcers. It is used also as a lotion in excessive sweating, acne, and seborrhœa. Either of the preparations may be employed, if diluted with water.

Internal.—The chief use of hydrastis is that it is empirically administered for chronic inflammations of mucous membranes. It is most used for uterine affections, particularly menorrhagia and dysmenor-

rhœa. It is given to stop uterine hæmorrhage and to arrest the growth of uterine tumours (*see also* Cotarnine, p. 382). For all these diseases hydrastinine hydrochloride has been much used. Hydrastis is also employed in the chronic gastritis of drunkards, and to a rather less degree in other forms of chronic gastro-intestinal catarrh. As an injection or lotion it is employed (either preparation diluted with an equal part of water) for chronic nasal catarrh, otorrhœa, leucorrhœa, gonorrhœa, and as a mouth wash in aphthous stomatitis and chronic pharyngitis. Some authors claim that it is useful for the same diseases of the heart as are benefited by digitalis. As an antiperiodic it is far inferior to quinine.

COTTON ROOT BARK.

Gossypii Radicis Cortex.—The dried root bark of *Gossypium herbaceum* and of other cultivated species.

CHARACTERS.—Thin flexible bands or quilled pieces, covered with a thin brownish yellow periderm.

Preparations.

1. Decoctum Gossypii Radicis Corticis.—1 in 5.

Dose, ½ to 2 fl. oz.—15 to 60 mils.

2. Extractum Gossypii Radicis Corticis Liquidum.—Cotton root bark, 100; glycerin, 25; alcohol (90 per cent.), 100. Percolate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTICS.

By many the action of this drug is thought to resemble that of ergot, and it is used in uterine diseases for the same purposes. It is chiefly employed in India, the East and West Indies, and North America.

BLACK HAW.

Viburnum.—Black Haw. The dried bark of *Viburnum prunifolium*.

CHARACTERS.—In quills or curved pieces, 1 to 4 millimetres thick, dull brown. Outer surface longitudinally wrinkled, or in older bark with shallow fissures and scaly. Taste astringent.

Preparation.

Extractum Viburni Liquidum.—1 in 1 of alcohol (70 per cent.). Percolate.
Dose, 1 to 2 fl. dr.—4 to 8 mils.

ACTION AND THERAPEUTICS.

The active principle has not been isolated, but black haw contains viburnin, and valerianic, tannic, gallic, oxalic, citric, and malic acids. From physiological experiments black haw appears to depress the motor functions of the cord, and so produce paralysis and loss of reflex. At the same time it depresses the heart, lowers the blood-pressure, and causes death by cardiac paralysis. In man large doses cause dimness of vision, dryness of mouth, and headache. Therapeutically, the drug has been used in hysteria, hystero-epilepsy, diarrhœa, dysentery, and, freely diluted, as a gargle in sore throats; but these uses are unimportant, and its chief employment is in obstetric diseases. In these it is used as a sedative; thus it is given a few days before the period in dysmenorrhœa and in menorrhagia; it is given to control uterine hæmorrhage during the menopause, and to relieve pains preceding and following childbirth. Given in the earlier months of pregnancy it is said to overcome the habit of miscarriage. It is used chiefly in India, the East, and North America.

GROUP XIII.

Colchicum, Piperazin.

These drugs are used for gout.

COLCHICUM.

Colchici Cormus.—Colchicum Corm. The fresh corm of *Colchicum autumnale*, collected in the early summer; or the same stripped of its coats, sliced transversely, and dried at a temperature not exceeding 65°C. Britain.

CHARACTERS.—Fresh corm 35 millimetres long, 25 millimetres broad, conical, flattened on one side, rounded on the other; outer coat thin, brown, membranous, inner coat reddish yellow. Internally white, solid, yielding milky juice of bitter taste and disagreeable odour. Dried slices 2 or 3 mm. thick, yellowish at circumference, indented one side, convex the other, and thus reniform in outline. Surfaces firm, whitish, amylaceous. Fracture short. Odour none. Taste bitter.

COMPOSITION.—The chief constituents are—(1) *Colchicine*, the active alkaloid, yellowish, micro-crystalline, soluble in water and alcohol, but changed by most acids into colchiceine. (2) Veratrine (*see* p. 463), in traces combined with gallic acid. (3) A fixed oil. (4) Starch, sugar, gum.

INCOMPATIBLES.—All astringent preparations, tincture of iodine, and tincture of guaiacum.

Preparations.

1. Extractum Colchici.—Made from the *fresh* corm by pressing out the juice, filtering and evaporating.

Dose, $\frac{1}{4}$ to 1 gr.—16 to 60 milligrms.

2. Vinum Colchici. — Colchicum corm, 1; sherry, 5. Macerate.

Dose, 10 to 30 m.—6 to 18 decimils.

Colchici Semina.—The dried ripe seeds of *Colchicum autumnale*.

CHARACTERS.—Two and a half millimetres in diameter, subglobular, pointed at hilum, reddish brown, rough, very hard and difficult to powder. Odour, none. Taste bitter, acrid. *Resembling colchicum seeds.*—Black mustard seeds.

COMPOSITION.—The chief constituents are—(1) The same as of the corm, but the proportion of the active alkaloid colchicine is larger. (2) A volatile oil in addition.

Preparation.

Tinctura Colchici.—Colchicum seeds, 1; alcohol (70 per cent.), 10. Percolate.

Dose, 5 to 15 m.—3 to 10 decimils.

This represents Tinctura Colchici Seminum, B. P. 1898. It is one half the strength of that preparation.

ACTION.

External.—When applied to the skin colchicum acts as an irritant, causing hyperæmia and smarting, and the dust inhaled gives rise to sneezing.

Internal.—*Gastro-intestinal tract.*—In moderate medicinal doses colchicum produces no effect on most persons beyond perhaps slightly increasing the secretion of bile, but with others it causes loss of appetite, and a little purging, nausea, and colic. In larger doses it gives rise, in all persons, to great abdominal pain, vomiting, and profuse diarrhœa with the passage of blood. It increases the secretion and stimulates the muscle. It is in fact a powerful gastro-intestinal irritant. There is also great prostration, the pulse becomes small, rapid, and thready, the skin cold and bedewed with sweat, and the respiration slow; death is due to collapse. It is probable that these results are not, to any large extent, owing to the effect of colchicine on the heart or respiration, but that they are the consequence of the severe gastro-enteritis, which, it is well known, will cause fatal collapse. They are produced if colchicine is injected subcutaneously, a circumstance which indicates that this alkaloid is an active principle of colchicum, and that it is excreted into the intestine. It is said that after a certain point increasing the quantity does not lead to an increase of the symptoms. In animals the action on the heart is not marked, but diarrhœa and vomiting are severe.

Nervous system.—Medicinal doses have no effect. Even a fatal dose does not impair consciousness

GROUP XIII.

Colchicum, Piperazin.

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COMPOSITION.—The chief constituents are—(1) *Colchicine*, the active alkaloid, yellowish, micro-crystalline, soluble in water and alcohol, but changed by most acids into colchiceine. (2) Veratrine (*see* p. 463), in traces combined with gallic acid. (3) A fixed oil. (4) Starch, sugar, gum.

INCOMPATIBLES.—All astringent preparations, tincture of iodine, and tincture of guaiacum.

Preparations.

1. Extractum Colchici.—Made from the *fresh* corm by pressing out the juice, filtering and evaporating.

Dose, $\frac{1}{4}$ to 1 gr.—16 to 60 milligrms.

2. Vinum Colchici. — Colchicum corm, 1; sherry, 5. Macerate.

Dose, 10 to 30 m.—6 to 18 decimils.

Colchici Semina. – The dried ripe seeds of *Colchicum autumnale.*

CHARACTERS.—Two and a half millimetres in diameter, subglobular, pointed at hilum, reddish brown, rough, very hard and difficult to powder. Odour, none. Taste bitter, acrid. *Resembling colchicum seeds.*—Black mustard seeds.

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Preparation.

Tinctura Colchici.—Colchicum seeds, 1; alcohol (70 per cent.), 10. Percolate.

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Nervous system.—Medicinal doses have no effect. Even a fatal dose does not impair consciousness

Cold-blooded animals bear much larger proportionate doses than warm, but in all, after large quantities, sensation is paralysed, and ultimately the spinal motor centres are powerfully depressed, death taking place from respiratory paralysis. Colchicine is said to act on muscles like veratrine.

Kidneys.—The most discordant statements have been made about the action of colchicum on the urine, but it has not been definitely shown that either the quantity or composition, even in the amount of uric acid, is altered. After death by poisoning, the alkaloid is found in the blood and in most of the organs of the body.

Blood.—The first effect is to diminish the number of polymorphonuclear cells in the blood owing to their collection in the tissues, especially the marrow, but soon there are fewer in the tissues and an enormous increase in those of the blood.

Therapeutics.

Colchicum is hardly ever used except for gout. Given during the attack, it most markedly relieves the pain; in smaller doses given between the attacks it diminishes their severity. It is often useful for dyspepsia, eczema, headache, neuritis, conjunctivitis, bronchitis, and other conditions which, when occurring in those suffering from gout, are probably related to it. It is a true specific; how it acts is not known. Occasionally it is combined with other reputed cholagogues, especially if it is desired to give these remedies to a person who is the subject of gout. If any symptoms of gastric or intestinal irritation appear, its use must be discontinued for a time. Those who take it should keep the bowels well open, lest it should accumulate in the body. Hence it is commonly combined with sulphate of magnesium. The seeds are said to be more active than

the corm. Colchicine salicylate, often known as colchisal, frequently relieves gouty pains. The dose is $\frac{1}{60}$ grain (1 milligrm.).

Piperazin.—(Not official.)

This organic base is formed by the action of sodium glycol on ethylenediamine hydrochloride. It was originally thought to be the same as spermine, an organic ferment obtained from the testicle, but it is quite a different body. It occurs in small colourless crystals soluble in water. Outside the body it is a powerful solvent of uric acid, but Fawcett ("Guy's Hospital Reports," vol. li.) and others have shown that the urine of a person taking piperazin will not dissolve uric acid, nor does it benefit gout. In spite of this evidence of its apparent uselessness it is much given, usually in 5-gr. (3 decigrms.) doses of a granular effervescing powder dissolved in half a tumbler of water. Some gouty patients profess to be much benefited by it, but others say it makes them worse. Lycetol (dose, 4 to 10 gr., 25 to 60 centigrms.) and Lysidine (dose, 10 to 30 ♏, 6 to 18 decimils) are allied bodies having similar properties.

GROUP XIV.

Camphor, Thymol, and Menthol are white solids, closely related to volatile oils, Ajowan oil is a volatile oil, all are antiseptic (two very powerfully so), and two at least, and probably all, are local anæsthetics.

Camphor, Thymol, Ajowan Oil, Menthol.

CAMPHOR.

Camphora.—$C_{10}H_{16}O$. A white crystalline substance obtained from *Cinnamomum camphora*, the camphor laurel, and purified by sublimation.

Characters.—Solid, colourless, translucent, crystalline masses; also in rectangular tablets or pulverulent masses known as "flowers of camphor." Tough, but readily powdered if mixed with alcohol, ether, or chloroform. Odour powerful, characteristic. Taste pungent, bitter, followed by a sensation of cold. Floats on water. Sp. gr. 0·99. Burns readily with a bright smoky flame. Volatilizes slowly at ordinary temperatures. Sublimes entirely when heated. *Solubility.*—1 in 700

of water, 1 in 2 of oil of turpentine, 1 in 4 of olive oil, readily in milk, ether, alcohol, or chloroform. When triturated with either chloral hydrate, carbolic acid, or thymol it forms a thick liquid.

COMPOSITION.—Camphor, $C_{10}H_{16}O$, is an oxidation product of pinene (*see* Oil of Turpentine), and may also be derived from cymene found in caraway and eucalyptus oils (*q.v.*). The pharmacopœial camphor is called laurel camphor; it is dextro-rotatory. Lævo-rotatory and inactive camphors are known. Borneol, $C_{10}H_{18}O$—known also as Borneo camphor—is often in commerce substituted for official camphor, which it closely resembles; it is derived from *Dryobalanops aromatica*, and is known from the official camphor by sinking in water; it is an alcohol. The common form of Borneol is dextro-rotatory, but lævo-rotatory and inactive varieties are known.

Dose, 2 to 5 gr.—12 to 30 centigrms.—as a pill, with glucanth and wheaten flour as an excipient.

Preparations.

1. **Aqua Camphoræ.**—Dissolve 1 grm. in 2 millilitres of alcohol (90 per cent.), and add to 1000 millilitres of distilled water. Contains about $\frac{1}{2}$ gr. to 1 fl. oz.
Dose, 1 to 2 fl. oz.—30 to 60 mils.

2. **Linimentum Camphoræ.** *Synonym.*—Camphorated Oil.—Camphor, in flowers, 1; olive oil, 4.

3. **Linimentum Camphoræ Ammoniatum.**—*Synonym.*—Compound Liniment of Camphor. Camphor, 125; strong solution of ammonia, 250; oil of lavender, 5; alcohol (90 per cent.), to 1000.

4. **Spiritus Camphoræ.**—Camphor, 1; alcohol (90 per cent.), to produce 10.
Dose, 5 to 20 m.—3 to 12 decimils. In milk or on sugar, as water precipitates the camphor.

5. **Tinctura Camphoræ Composita,** *see* Opium, p. 363.

Camphor is contained in the following liniments: Aconiti, Belladonnæ, Chloroformi, Hydrargyri, Opii, Saponis, Sinapis, Terebinthinæ, and Terebinthinæ Aceticum; and in Unguentum Hydrargyri Compositum.

Spiritus Camphoræ Fortior, known as Rubini's solution of camphor, is 1 of camphor in 1 of absolute alcohol.

Action.

External.—Camphor, although not a volatile oil, acts very much like one. Thus it is a direct cutaneous stimulant, dilating the vessels of the skin, and at first causing a sensation of warmth, but subsequently a slight degree of local anæsthesia. It is a feeble antiseptic.

Internal.—*Gastro-intestinal tract.*—In the stomach it is mildly stimulant, dilating the vessels, increasing the flow of gastric juice and the peristalsis. Hence it is stomachic and carminative. It has a slight reflex stimulating effect on the heart. In ordinary doses it has little action on the intestines.

Absorption.—It is quickly absorbed, both from the intestines and skin, and two bodies formed in the body from it are known. One, camphorol (one atom of H in camphor is replaced by OH), combines with glycuronic acid and is excreted in the urine as camphoglycuronic acid. Another, an amido derivative, is also found in the urine.

Circulation.—It increases the number of polymorphonuclear cells in the blood. The heart is excited directly by it in addition to the reflex stimulation just mentioned, and so the pulse becomes fuller and stronger; the rate is not much affected. The face may be flushed. The effect on the circulation is very slight in man.

Respiration.—Probably camphor or some derivative from it is excreted by the bronchial mucous membrane, the vascularity and secretion of which are consequently stimulated. It has the reputation of being a feeble expectorant.

Skin.—It is a mild diaphoretic. This effect is believed to be due to the action of the drug on the central nervous system. Probably camphor or some derivative from it is excreted by the skin, for the sweat may smell of it.

Nervous system.—Different people are differently susceptible to the effects of camphor. Five to ten grains will, like alcohol, in some persons produce a feeling of exhilaration, or in others a sense of comfort and quietness. Larger doses cause excitement, giddiness, staggering, a slow pulse, and ultimately headache, burning pains in the stomach, faintness, confusion of ideas, delirium, violent convulsions, insensibility, a small feeble pulse, and finally death from collapse. In mammals, including man, camphor acts by first stimulating and subsequently depressing the cerebral cortical areas. It is a mild antipyretic.

Sexual organs.—Camphor is reputed to be an aphrodisiac, but this is probably incorrect.

THERAPEUTICS.

External.—Its stimulating effects make camphor a favourite ingredient of many liniments. It is constantly rubbed into the skin in some form or another as a mild irritant or counter-irritant in, for example, chronic rheumatism, chronic inflammatory indurations, and the slighter chest complaints of children; and also in myalgia, neuralgia, lumbago, and sciatica, in which cases, because of its property of causing local anæsthesia, it relieves pain. In addition to the pharmacopœial preparations, a Chloroformum Camphoræ B. P. C. (camphor, 2 parts, dissolved in chloroform, 1 part) may be used. The liquid preparations with chloral, carbolic acid, and thymol are excellent local anodynes for neuralgia, and may be dropped into a tooth to relieve toothache.

Internal.—Camphor is used as a carminative, especially for neurotic subjects. It is a common remedy for a cold in the head, and is probably beneficial on account of its stimulation of the circulation and its slight antipyretic and diaphoretic effects.

Many expectorant mixtures contain camphor. Large doses are said to check diarrhœa. It has been given as an antispasmodic in hysteria and allied conditions, and some state that it is of use in cholera and as a stimulant when the heart is weak. It is believed to greatly lessen the disagreeable symptoms that follow on cessation of the morphia habit. It is much used as a cardiac stimulant, 3 grains (20 centigrms.) or more being injected subcutaneously as a solution in sterilized olive oil; but it is probably of little value.

THYMOL.

Thymol.—*Synonym.*—Isopropyl metacresol $C_{10}H_{14}O$. A crystalline substance obtained from the volatile oils of *Thymus vulgaris*, *Monarda punctata*, and *Carum copticum*. Purified by recrystallization from alcohol.

CHARACTERS.—Large, oblique, prismatic crystals. Odour of thyme. Taste pungent, aromatic. *Solubility.*—1 in 1500 of cold water, 1 in 190 of glycerin, 1 in 2 of olive oil. Freely in alcohol, ether, or chloroform.

Dose, ½ to 2 gr.—3 to 12 centigrms.; 15 to 30 gr.—1 to 2 grms. (anthelmintic).

ACTION AND THERAPEUTICS.

Thymol is a more powerful antiseptic than carbolic acid, but its insolubility is a drawback. It has been used in antiseptic surgery. It is non-irritating. It has considerable antiparasitic powers, and solutions in alcohol or ether (1 in 15) have been used in ringworm. A solution in glycerin (1 in 200) has been recommended for sore throats. A little alcohol is very useful for facilitating the aqueous solution of thymol.

Thymol in three daily successive doses of 30 gr. (2 grms.) each given in a cachet is the best anthelmintic for the hook worms, *Necator americanus* and *Ankylostoma duodenale*. A purgative should be

given before and after and the patient is starved during treatment. Thymol may make the urine green.

AJOWAN OIL.

Oleum Ajowan. *Synonym.*—Ptychotis oil. The oil distilled from the fruit of *Carum copticum.*

CHARACTERS.—Colourless, with an odour and taste resembling thyme. Sp. gr. 0·91–0·93.

Dose, $\frac{1}{2}$ to 3 m.—3 to 18 centimils.

ACTION AND THERAPEUTICS.

An alcoholic solution of it has been used to relieve pain, and it is given internally as a carminative. It is chiefly used in India and the Eastern Indies.

MENTHOL.

Menthol.—$C_{10}H_{20}O$. A crystalline substance obtained by cooling the oil distilled from the fresh herb of *Mentha arvensis*, vars. *piperascens et glabrata* (Japan) and probably other species of Mentha. It is sometimes called mint camphor.

CHARACTERS.—In fused crystalline masses or as colourless acicular crystals, moist from adhering oil. Odour as of peppermint. Taste of peppermint; the subsequent coldness on inhalation of air is well marked. Its melting-point should not exceed 43°C. *Solubility.*—Very sparingly in water or glycerin, 5 in 1 of alcohol (90 per cent.), 4 in 1 of chloroform, 1 in 4 of olive oil.

IMPURITIES.—Glass and magnesium sulphate.

Dose, $\frac{1}{2}$ to 2 gr.—3 to 12 centigrms.

Preparation.

Emplastrum Menthol.—Menthol, 15; yellow beeswax, 10; resin, 75.

ACTION AND THERAPEUTICS.

External.—Menthol is chiefly employed externally, for it produces local anæsthesia, a feeling of coldness and numbness, and thereby alleviates the pain of neuralgia, especially if it involves a superficial nerve.

It is very efficacious in some cases. The solid menthol may be drawn along the skin, or a spirituous solution may be painted on, or the plaster may be applied. If this is used it should be spread on thin rubber cloth or hat lining, as it soaks through calico and linen. In very hot weather the pharmacopœial plaster may be too fluid, and then more wax should be added. A solution of 100 gr. (7 grm.) heated in a test-tube containing half an ounce of oleic acid is an excellent preparation, and a very good liniment is formed of menthol, 3 parts; chloroform, 4 parts; olive oil, 9 parts. The local application of menthol often relieves itching. Menthol has been applied locally to carious teeth, and has been inhaled with advantage in asthma. For teeth it is best rubbed up with an equal part of absolute phenol, camphor, or chloral hydrate. The oily liquid formed in either case may be put in the tooth. For asthma it is readily volatilised by the addition of hot water. Solutions of it have been painted on the throat in diphtheria. A pigment of 1 to 4 in olive oil is employed for painting the larynx in tubercular ulceration. Glycothymolin contains thymol, menthol, and other bodies. It is used as an antiseptic wash for mucous membranes.

Internal.—Its internal administration has been abandoned, as it easily upsets digestion. It is a powerful antiseptic, and is excreted in the urine as menthoglycuronic acid, rendering it aseptic and giving it a pleasant smell. Menthol should be preserved in closed tin boxes.

GROUP XV.

Vegetable Drugs acting in virtue of important Acids they contain.

Lemon juice (citric acid), **Benzoin** (benzoic acid), **Laurocerasi Folia** (hydrocyanic acid), **Araroba, Chrysarobinum** (chrysophanic acid), **Chaulmoogra Oil** (gyno-

cardic acid). *Virginian prune* (*see* p. 473) and *Bitter almond* (*see* p. 609), both of which yield hydrocyanic acid, have already been considered.

LEMON.

Limonis Cortex.—Lemon Peel. The fresh outer part of the pericarp of the fruit of *Citrus medica, var. β Limonum.*

CHARACTERS.—Thin, pale yellow pieces, rough on the outer surface from the presence of glands containing the oil; inner surface has a little of the inner white rind attached. Fragrant odour; bitter aromatic taste.

COMPOSITION.—The chief constituents are—(1) The official *Oleum Limonis* (*see below*). (2) A bitter principle, hesperidin.

Preparations.

1. **Syrupus Limonis,** *see* p. 647.
2. **Tinctura Limonis.**—Lemon peel, 1; alcohol (90 per cent.), 4. Macerate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

Lemon peel is contained in Infusum Aurantii Compositum and Infusum Gentianæ Compositum.

In India and the Colonies where fresh lemon peel cannot be obtained, the dried peel may be used for any preparations containing lemon peel.

Oleum Limonis.—The oil obtained from fresh lemon peel.

SOURCE.—Obtained by expression.

CHARACTERS.—It is pale yellow, fragrant, warm, and bitter. Sp. gr. 0·857 to 0·860.

COMPOSITION.—Oil of lemon contains—(1) A terpene called *citrene* or *limonene*, $C_{10}H_{16}$, 90 per cent., strongly dextro-rotatory. This is also found in orange peel and in oil of caraway. (2) Geranial or citral, the aldehyde derived from geraniol found in oil of rose (p. 559). (3) Citronellal, an aldehyde of the alcohol citronellol.

Dose, $\frac{1}{2}$ to 3 m.—3 to 18 centimils.

Oil of lemon is contained in Linimentum Potassii Iodidi cum Sapone, Tinctura Valerianæ Ammoniata, Tinctura Guaiaci Ammoniata, and Spiritus Ammoniæ Aromaticus.

ACTION AND THERAPEUTICS.

The same as those of orange. The oil applied externally is rubefacient.

Succus Limonis.—Lemon Juice. The freshly ex-pressed juice of the ripe fruit of *Citrus medica, var. β Li*[illegible]

CHARACTERS.—A pale yellow, slightly turbid liquid, [illegible] acid. Odour of lemons. 100 millilitres of lemon [illegible] neutralized by about 11·4 grms. of potassium bicarbonate, by about 9·5 grms. of sodium bicarbonate, and by about 16·5 grms. of sodium carbonate. It decomposes on keeping, but may be preserved by the addition of 10 per cent. of alcohol.

COMPOSITION.—Lemon juice contains citric acid (*see* p. 269), both free and combined to form potassium and other salts. Also malic acid, $H_2C_4H_4O_5$, and phosphoric acid.

Preparations.

1. **Syrupus Limonis.**—Fresh lemon peel 20, is digested in alcohol (90 per cent.) q.s. Sugar, 760, is dissolved in lemon juice 500, and the two liquids are mixed.

   Dose, ½ to 1 fl. dr.—2 to 4 mils.

2. **Acidum Citricum,** *see* p. 269.

ACTION AND THERAPEUTICS.

Lemon juice is used to relieve thirst, and to make effervescing mixtures and drinks. Its action in the body is the same as that of citric acid (*see* p. 269). Three or four ounces of lemon juice daily is of great benefit in scurvy, as it contains the vitamine C, the deficiency of which in the food causes this disease.

BENZOIN.

Benzoinum.—Benzoin. *Synonym.*—Gum Benjamin. A balsamic resin obtained from the incised stem of *Styrax benzoin.* Known as Sumatra benzoin.

CHARACTERS.—Separate tears or masses of tears loosely agglutinated, but generally closely compacted by a deep brown translucent substance. Tears flat or curved, yellowish or reddish brown; they vary in size up to an inch or two; on breaking they either show an opaque milk-white or a reddish-brown appearance. Benzoin is very brittle, and easily softens by the heat of the mouth. Little taste. Odour balsamic. Given

off, on heating, fumes of benzoic acid. *Solubility.*—1 in 5 of alcohol (90 per cent.). Easily in ether or potash.

Composition.—The chief constituents are—(1) *Benzoic acid* (*see below*), 12 to 20 per cent. (2) Cinnamic acid, $C_9H_8O_2$, a trace. (3) Resins. (4) Volatile oil.

Preparations.

1. **Adeps Benzoatus.**—Benzoated lard. Benzoin, 3; prepared lard, 100.

2. **Sevum Benzoatum.** — Benzoated suet. Benzoin, 3; prepared suet, 100.

3. **Tinctura Benzoini Composita.** *Synonym.*—Friar's balsam. Benzoin, 100; prepared storax, 75; balsam of tolu, 25; aloes, 20; alcohol (90 per cent.), to produce 1000. Macerate.

Dose, $\frac{1}{2}$ to 1 fl. dr.—2 to 4 mils.

Benzoated lard is contained in several ointments, but in India *benzoated suet* should be employed in making the official preparations for which benzoated lard is directed to be used.

Acidum Benzoicum.—Benzoic Acid. $HC_7H_5O_2$.

Source.—From benzoin by sublimation or synthetically from toluene, hippuric acid, and other organic compounds.

Characters.—Light, feathery, almost colourless, flexible, crystalline plates or needles. *Solubility.*—1 in 450 of cold water, 1 in 12 of boiling water, readily in solutions of alkalies. Sodium phosphate or borax aids its solution in water. It sublimes on heating.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Preparations.

1. **Trochiscus Acidi Benzoici.**—0·03 grm. or $\frac{1}{2}$ gr. in each with a fruit basis.

2. **Tinctura Camphoræ Composita.**—0·5 per cent. of benzoic acid (*see* Opium, p. 363).

3. **Tinctura Opii Ammoniata.**—2 per cent. of benzoic acid (*see* Opium, p. 363).

Ammonii Benzoas.—$NH_4C_7H_5O_2$.

Source.—Neutralize benzoic acid with ammonia, and evaporate.

Characters.—Colourless laminar crystals, with odour of benzoic acid. *Solubility.*—1 in 6 of water, 1 in 22 of alcohol (90 per cent.).

Incompatibles.—Per-salts of iron, Liquor Potassæ, and acids.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Sodii Benzoas.—$NaC_7H_5O_2$.

Source.—Neutralize a solution of benzoic acid with sodium carbonate, and crystallize.

Characters.—A crystalline or amorphous white powder. Odour faintly benzoic. Taste sweetish, alkaline. *Solubility.* —Easily in water, 1 in 24 of alcohol (90 per cent.).

Dose, 5 to 30 gr.—3 to 20 decigrms.

Action.

As far as is known, the action of benzoic acid, its salts, and benzoin is the same. We shall therefore only here describe the actions of benzoic acid.

External.—Benzoic acid is a powerful antiseptic. The growth of many forms of bacteria is completely inhibited by a solution of 1 in 1000. In a concentrated form it is a stimulant and irritant when applied to the skin.

Internal.—The chief fact about the internal action of benzoic acid that has been worked out is that when it is given by the mouth hippuric acid appears in the urine. This happens by combination with a molecule of glycocoll, $C_6H_5{\cdot}COOH + NH_2{\cdot}CH_2{\cdot}COOH = C_6H_5{\cdot}CO{\cdot}NH{\cdot}CH_2{\cdot}COOH$ (hippuric acid) $+ H_2O$. The source of the glycocoll is not known. The conversion takes place in the kidneys, for after giving large doses of benzoic acid it alone can be found in the blood, and if the renal arteries are tied no hippuric acid is formed, but if only the ureters are tied it is formed. Also benzoic acid has been successfully converted into hippuric acid by passing blood containing benzoic acid, but no glycocoll, slowly through the kidneys removed directly after death. Further researches show that the conversion is probably effected by the renal cells. Hippuric acid has been found in the urine of new-born children when benzoic acid has been given to the mother shortly before delivery. If hippuric acid is given by the mouth benzoic acid

is found in the blood, but hippuric reappears in the urine. The hippuric acid in the urine renders alkaline urine acid, and it stimulates and disinfects the urinary mucous membrane. Occasionally succinic acid as well as hippuric acid appears in the urine.

Benzoic acid or some derivative of it is probably excreted in the bronchial secretion, for the bronchial mucous membrane is stimulated by the administration of benzoic acid, the mucus being increased in quantity and disinfected. The acid is therefore expectorant. The same effects are brought about if the vapour of benzoic acid is inhaled.

It is said also to be excreted by the skin and salivary glands, and thereby to increase their activity. It is slightly diuretic. Medicinal doses do not produce any effect on the stomach, intestines, circulation, or nervous systems, but greatly increase the polymorphonuclear cells in the blood.

Benzoic acid and its salts are antipyretic, and it is stated that they are even more powerful than salicylic acid. How they produce a fall of temperature is not known. Metabolism is increased, as is shown by the excess of nitrogen and sulphur in the urine.

Sodium and ammonium benzoate were formerly thought to be direct cholagogues.

Therapeutics.

External.—Lint soaked in the compound tincture is a very favourite dressing for wounds and sores of all sorts. Its chief advantage is the antiseptic power it possesses. Its stimulating effect is also valuable. Benzoated lard is a common basis for ointments when it is wished that the active ingredient should be absorbed, for the lard melts on the body, especially if covered by a bandage; the benzoin prevents the decomposition of the lard. If the benzoin irritates, which it is especially likely to do if near the eye,

three minims of oil of cloves or two of oil of gaultheria to the ounce of lard make a non-irritant basis that keeps indefinitely.

Internal.—*Lungs.*—Benzoin, benzoic acid and its compounds are very commonly employed as stimulating disinfecting expectorants in cases of bronchitis or phthisis in which the expectoration is foul and scanty. The vapour from a mixture of a pint of water at 52°C. and a fluid drachm (4 mils) of compound tincture of benzoin is often inhaled for bronchitis and laryngitis.

Urinary organs.—Benzoic acid is a most valuable drug for acidifying the alkaline decomposing urine which is formed in pyelitis and cystitis, and for stimulating and disinfecting the urinary tract in the same conditions. Benzoate of ammonium is so much more soluble than benzoic acid that it is to be preferred to it. Spirit of chloroform covers the taste. It may with advantage be combined with urinary sedatives. as tincture of hyoscyamus. The conversion to hippuric acid has been said not to take place when the kidney is diseased.

Benzoic acid has been used in Germany instead of salicylic acid for rheumatic fever.

CHERRY LAUREL.

Laurocerasi Folia.—Cherry Laurel Leaves. The fresh leaves of *Prunus laurocerasus.*

Characters.—Thick, coriaceous, on short strong petioles. Oblong or ovate, 12 to 18 centimetres long, tapering towards each end, recurved at the apex, distantly but sharply serrated, dark green, smooth and shining above, pale beneath. Prominent midrib with, on either side of it, at the base, one or two glandular depressions. Inodorous except on bruising, when they emit a prussic acid or ratafia-like odour.

Composition.—The chief constituents are—(1) *Laurocerasin,* a glucoside; it is identical with amygdalin. By the same changes as is the case with bitter almonds (*see* p. 609), in the presence of moisture, an oil, prussic acid and glucose are formed. (2) *Emulsin.*

Preparation.

Aqua Laurocerasi.—Made by distillation, and *standardized* by adding either water or hydrocyanic acid till the strength of the distillate is 0·1 *per cent. of hydrocyanic acid.* That is to say, the relative strength of Acidum Hydrocyanicum Dilutum and Aqua Laurocerasi is as 20 to 1.

INCOMPATIBLES.—Metallic salts.

Dose, ½ to 2 fl. dr.—2 to 8 mils (note the dose).

ACTION AND THERAPEUTICS.

Aqua Laurocerasi is not often employed, for, owing to the volatilization of the prussic acid, its strength is inconstant. Its actions are the same as those of dilute hydrocyanic acid (*see* p. 352). It is given as a flavouring agent.

ARAROBA.

Araroba.—*Synonyms.*—Goa Powder; Crude Chrysarobin. A substance found in cavities in the trunk of *Andira araroba*, freed as much as possible from fragments of wood, dried and powdered.

CHARACTERS AND TESTS. — The powder varies from brownish-yellow to umber brown. It should yield to hot benzene not less than 50 per cent. of a substance which, after evaporating and drying, should have the characters of chrysarobin.

Used for making chrysarobin.

CHRYSAROBIN.

Chrysarobinum.—Chrysarobin.

SOURCE. — A mixture of substances extracted from Araroba by hot benzene.

CHARACTERS.—A light brownish-yellow minutely crystalline powder, tasteless and inodorous. *Solubility.*—Very sparingly in water, and sparingly in alcohol (90 per cent.).

COMPOSITION.—It consists of a definite chemical compound, $C_{15}H_{12}O_3$, also known as pure chrysarobin, or chrysophanolanthranol, associated with other substances of a similar composition.

Preparation.

Unguentum Chrysarobini.—Chrysarobin, 4; soft paraffin, 96.

ACTION.

External.—It is a powerful irritant to the skin, which it stains yellowish brown. Linen is stained the same colour. (The stain may be removed by a weak solution of caustic soda or chlorinated lime.) It is antiparasitic.

Internal.—It is cathartic and very irritating to the stomach and bowels, causing vomiting and purging. It is excreted by the kidneys, and stains the urine yellow.

THERAPEUTICS.

It is used as an antiparasitic in ringworm, and to excite healthy inflammation in chronic cutaneous diseases, especially psoriasis and acne rosacea. Pigmentum Chrysarobini, B. P. C. (chrysarobin, 1; solution of gutta percha, 9) is more cleanly than the ointment and does not stain the clothes. Chrysarobin has also been given internally for skin diseases, but as it is so irritating this practice is not advisable.

CHAULMOOGRA OIL.

Oleum Chaulmoogræ. *Synonym.*—Gynocardia oil. The fatty oil expressed from the seeds of *Taraktogenos Kurzii.*

CHARACTERS.—A brownish yellow oil or soft fat, with characteristic odour and somewhat acrid taste. Soluble in ether, chloroform, or alcohol.

Composition.—Its chief constituents are hydnocarpic and chaulmoogric acids, both unsaturated fatty acids.

Oleum Chaulmoogræ was called Oleum Gynocardiæ in B. P. 1898.

Dose, 5 to 10 m.—3 to 6 decimils—increased to ½ to 1 fl. dr.—2 to 4 mils. It is best given in capsules.

Preparation.

Unguentum Chaulmoogræ.—Gynocardia oil, 1; hard paraffin, 4; soft paraffin, 5.

Action and Therapeutics.

Externally the oil is a powerful rubefacient, and may cause great pain when applied to raw places, but an ointment (3 fl. dr. to 1 fl. oz. of lanolin) has been used for very chronic psoriasis. Internally it is a gastro-intestinal irritant. It has been much used for leprosy, both externally and internally, but it is very nasty and upsets the stomach. It is best to inject a 3 per cent. solution of sodium hydnocarpate. This treatment cures leprosy by destroying the bacillus of the disease.

GROUP XVI.

Vegetable Drugs used only as Colouring Agents.

Red Sanders-wood, Sappan.

RED SANDERS-WOOD.

Pterocarpi Lignum.—Red sanders-wood. *Synonym.*—Red sandal wood. The heart-wood of *Pterocarpus santalinus.* Ceylon.

Characters. — Dense, heavy logs; dark brown externally, internally deep blood-red. Chips deep reddish brown. *Resembling sanders-wood.*—Logwood, which is less dense.

Composition.—The chief constituent is a blood-red crystalline principle, santalic acid or santalin.

Sanders-wood is contained in Tinctura Lavandulæ Composita.

Action and Therapeutics.

Sanders-wood is used to colour preparations.

SAPPAN.

Sappan.—The heart-wood of *Cæsalpinia sappan.*

CHARACTERS.—In hard, heavy sections of variable size, or in orange red chips. The transverse section shows well-marked concentric rings and numerous rays.

Preparation.

Decoctum Sappan.—Sappan, 50; cinnamon bark, 10; water, to 1000.

Dose, ½ to 2 fl. oz.—15 to 60 mils.

ACTION AND USES.

Before the introduction of aniline dyes sappan wood was used largely to dye fabrics red. It is also used to make red ink. It contains tannin, and is employed in pharmacy to colour mixtures red, especially when an astringent effect is desired. It is used chiefly in India and the East Indies.

GROUP XVII.

Vegetable substances whose action is mechanical.

Cotton, Collodion, Oil of Theobroma, Quillaia, Starch.

COTTON.

Gossypium.—Cotton. *Synonym.*—Cotton Wool. The hairs of the seeds of *Gossypium herbaceum*, and of other cultivated species of *Gossypium*, from which the fatty matter has been removed. This is commonly called "Absorbent Cotton Wool." Ordinary cotton wool is called "Non-Absorbent." It contains 10 per cent. of fixed oil.

From gossypium is made—

Pyroxylinum.—Pyroxylin or Dinitrocellulose, $C_6H_8(NO_2)_2O_5$. Gossypium is immersed in a mixture of sulphuric and nitric acids, and then drained and dried. Soluble in a mixture of ether and alcohol (90 per cent.). Resembles cotton wool but is harsher to touch. Highly inflammable.

Preparations.

1. Collodium.—Pyroxylin, 21; dissolved in ether, 750; and alcohol (90 per cent.), 250.

2. Collodium Flexile.—Collodion, 48; Canada balsam, 2; castor oil, 1.

3. Collodium Vesicans. — Pyroxylin, 25; cochineal, 10; liquor epispasticus to produce 1000.

Action and Therapeutics.

The use of cotton wool is well known. Cotton wool, lint, and gauze are frequently medicated, *e.g.* Sal Alembroth, 1 or ½ per cent.; mercuric chloride, 0·1 per cent.; boric acid, 40 per cent.; carbolic acid, 5 per cent.; iodoform, 10 or 20 per cent.; mercury and zinc cyanide, 3 per cent. All these gauzes are in the B. P. C.

Pyroxylin is only used to make collodion.

Collodion, when painted on the skin, rapidly dries from evaporation of the ether, and covers the skin with a thin protective film. Collodium Flexile has the same properties, but it does not crack, as collodion often does. These preparations are protective to small wounds, and are used after slight operations. If the end of the urethra or prepuce is at night closed with collodion, nocturnal incontinence may sometimes be cured.

OIL OF THEOBROMA.

Oleum Theobromatis. *Synonym.*—Cacao butter. A solid fat obtained by expression from the seeds of *Theobroma cacao*. Growing in Demerara and Mexico. Chocolate is prepared from the roasted kernels of these seeds by the addition of sugar and vanilla. Cocoa is prepared from them by partly removing the oil of theobroma by pressure and then roasting and grinding the kernels.

Characters.—Is of the consistency of tallow; yellowish, with chocolate-like odour. Taste bland and agreeable. Fracture clean. Does not become rancid on exposure to air. Melts at 30° to 33°C.

Composition.—The chief constituents are—(1) *Stearin.* (2) A little olein. (3) An alkaloid, theobromine, $C_7H_8N_4O_2$, for the action of which see p. 407.

Oil of theobroma is contained in all Suppositoria except those of glycerin.

Action and Therapeutics.

It is only used to make suppositories.

QUILLAIA BARK.

Quillaiæ Cortex. *Synonyms.*—Panama bark; Soap bark. The dried inner part of the bark of the tree *Quillaja saponaria.*

Characters.—Large flat pieces, 3 to 8 millimetres thick, of varying length and width. Outer surface brown, inner white. It imparts a soapy character to cold water, and is used to diffuse oily liquids through water.

Composition.—The chief constituent is saponin, a glucoside (*see* p. 466).

Quillaia bark is used to emulsify the tar in Liquor Picis Carbonis when it is diluted (*see* p. 530).

Preparation.

Tinctura Quillaiæ.—Bark, 1; alcohol (60 per cent.), 20. Percolate.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

Action and Therapeutics.

Saponins occur in many plants, but that derived from some plants is more poisonous than that derived from others. The more poisonous varieties are called sapotoxins. All saponins form a frothy solution in water, and hence tincture of quillaia is largely employed to make a lather for shampooing, and might be used to aid the diffusion of oils and other insoluble bodies, but for the fact that its saponin is a powerful gastro-intestinal irritant. If saponin is absorbed, in its excretion it irritates the bronchial mucous membrane. Hence the use of senega (*see* p. 465) as an expectorant. Saponin is a general protoplasmic poison, and as it is also a gastro-intestinal irritant the use of drugs containing much of it is not desirable.

STARCH.

Amylum.—Starch $(C_6H_{10}O_5)_n$. The starch procured from the grains of wheat, *Triticum sativum*; maize, *Zea Mays*; rice, *Oryza sativa*.

Characters.—Well known.

Preparation.

Glycerinum Amyli.—Starch, 2; glycerin, 13 water, 3.

Starch is contained in Pulvis Tragacanthæ Compositus.

Action and Therapeutics.

Starch is chiefly employed for its mechanical properties, on account of which it is used as a basis for dusting powders and insufflations. Mucilage of starch, which is made by triturating 120 gr. (8 grms.) of starch with 10 fl. oz. (300 mils) of water, gradually added and then boiled and stirred for a few minutes, may be used as a basis for ointments, and to suspend insoluble powders or oils; it is very handy as a basis for enemata, but does not keep well and is therefore not suitable as a vehicle for a mixture.

GROUP XVIII.

Vegetable Substance whose Action is Not Known.

Guaiacum.

GUAIACUM WOOD.

Guaiaci Lignum. *Synonym.*—Lignum vitæ. The heart-wood of *Guaiacum officinale* or of *Guaiacum sanctum*. West Indies.

Characters.—Dark greenish brown, dense, hard, and heavier than water. Taste acrid and aromatic. Odour, if rubbed or heated, faintly aromatic.

Composition.—The chief constituent is the resin, 20 to 25 per cent. (*q.v.*).

Guaiaci Resina.—Guaiacum Resin. The resin obtained from the stem of *Guaiacum officinale* or of *Guaiacum sanctum.*

CHARACTERS.—Usually in large masses, occasionally in roundish tears. Surface brown or greenish brown, covered, after exposure, with a greenish powder. Fracture clean and glassy. Odour balsamic. When chewed gives acrid sensation in the throat. An alcoholic solution strikes a clear blue colour when applied to the inner surface of a potato (fresh protoplasm), or when treated with tincture of iron. Guaiacum resin on dry distillation yields amongst other substances cresol and *guaiacol,* also found in creosote (*see* pp. 342 and 343). *Resembling guaiacum resin.*—Myrrh, scammony, benzoin, aloes, and resin, but these have no green tinge.

COMPOSITION.—The chief constituents are three resins—Guaiaconic acid, $C_{19}H_{20}O_5$ (70 per cent.); guaiac acid, resembling benzoic acid; and guaiaretic acid. These are insoluble in water, soluble in alkalies, but precipitated on neutralization.

INCOMPATIBLES.—Mineral acids, spirit of nitrous ether.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Preparations.

1. **Mistura Guaiaci.** — Guaiacum resin, 25; sugar, 25; tragacanth, 5 (to suspend the resin); cinnamon water, 1000. (The resin very quickly falls.)

Dose, ½ to 1 fl. oz.—15 to 30 mils.

2. **Tinctura Guaiaci Ammoniata.**—Guaiacum resin, 200; oil of nutmeg, 3; oil of lemon, 2; strong solution of ammonia, 75; alcohol (90 per cent.), to make 1000. Macerate. As the resin is precipitated on dilution of the ammonia it must be suspended by adding mucilage or yolk of egg.

Dose, ½ to 1 fl. dr.—2 to 4 mils.

3. **Trochiscus Guaiaci Resinæ.**—0·2 grm. or 3 gr. in each, with a fruit basis.

4. **Pilula Hydrargyri Subchloridi Composita.**—1 in 2½ (*see* p. 212).

ACTION.

External.—None.

Internal.—Guaiacum resin gives rise to an acrid feeling in the throat and a sensation of heat in the

epigastrium. It increases the secretions and movements of the intestine and stomach. Large doses are gastro-intestinal irritants, causing vomiting and purging. It reflexly stimulates the heart.

THERAPEUTICS.

Internal.—Guaiacum resin is so nasty and its value so doubtful that it is rarely ordered. It is used empirically, sometimes successfully, for chronic sore throat, especially if the subject has had syphilis. The mixture is said to be a more efficacious preparation than the tincture. Thirty grains (2 grms.) of the powder itself may be placed on the back of the throat and swallowed, but the lozenge is to be preferred. Guaiacum is a mild purgative, and it has been given as a pill in chronic constipation; this property accounts for its presence in compound calomel pills. It has been strongly recommended as a means of warding off attacks of gout. For this purpose 12 grains (8 decigrms.) of the powdered resin may be taken in a cachet for an indefinite period, even several years. Some follow it by a draught of effervescing citrate of lithium. It was formerly employed for chronic rheumatism.

SECTION II.—SUBSTANCES DERIVED FROM THE ANIMAL KINGDOM.

SUET.

Sevum Præparatum.—The purified internal fat of the abdomen of the sheep, *Ovis aries*.

COMPOSITION.—(1) Olein, 30 per cent. (2) Palmitin. (3) Stearin.

Suet is contained in Unguentum Hydrargyri.

Sevum Benzoatum.—Benzoated Suet. Benzoin, 3; prepared suet, 100. Melt the suet, add the benzoin, keep at 60° for one hour. Strain and stir till nearly cold.

In India benzoated suet should be employed in making the official preparations for which benzoated lard (Adeps Benzoatus) is directed to be used (*see* p. 648).

CURD SOAP.

Sapo Animalis.—Curd Soap. Soap made with sodium hydroxide and a purified animal fat consisting principally of stearin. It is chiefly stearate of sodium, but contains some palmitate of sodium and about 30 per cent. of water.

Curd soap is contained in Extractum Colocynthidis Compositum and Linimentum Potassii Iodidi cum Sapone.

Action and Therapeutics.

Curd soap is employed as a basis, and, like hard soap (*see* p. 603), may be used for medicated soaps.

ADEPS LANÆ.

Adeps Lanæ.—Wool Fat. *Synonym.*—Anhydrous Lanolin. The purified fat of sheep's wool freed from water. For Adeps Præparatus *see* p. 665.

Characters.—Semi-transparent, pale yellow, tenacious body. Ignited it burns with a sooty flame. Melts about 40°C. Odour faintly like sheep's wool. *Solubility.*—Freely in chloroform and in ether, partially in alcohol. Insoluble in water, but on vigorous stirring takes up 1¼ times its own weight.

Adeps Lanæ is contained in Unguentum Hamamelidis and Emplastrum Cantharidini.

Preparation.

Unguentum Lanæ Compositum.—Prepared lard, 40; wool fat, 40; paraffin ointment, 20. *Synonym.*—Emollient Ointment.

In India prepared suet should be used instead of prepared lard.

Adeps Lanæ Hydrosus.—Hydrous wool fat. *Synonym.*—Lanolin.

Source.—Incorporate 3 of water with 7 of wool fat, and melt in a warm mortar.

Characters.—Opaque, very pale yellow, softer than wool fat. On heating it separates into an upper oily and a lower aqueous layer. Glycerin abstracts the water.

Action and Therapeutics.

Hydrous wool fat when gently rubbed on the skin is more quickly absorbed than most fats; hence it is a useful basis if we wish to administer substances—as, for example, mercury—by inunction, or if we want an ointment to be absorbed.

Milk, Artificial Human.—(Not official.)

Preparation.—Add 3 5 per cent. of Pulvis Pancreaticus Co. (B. P. C.) to sugar of milk, forming "milk powder." Triturate 6·5 of milk powder with 62 of water, add the mixture to 62 of fresh cow's milk enriched by the addition of 15 of fresh cream. Immerse the bottle containing the whole in water heated to 38°C. for 15 minutes, then heat the mixture quickly to boiling point and allow it to immediately cool to the body temperature. Humanized milk should be prepared immediately before use.

Action and Therapeutics.

Artificial human milk is invaluable as a food for infants whose mothers cannot suckle them. Many cases of infantile diarrhœa, indigestion, and sickness can be cured by substituting this milk for the usual milk and water or other infants' food. Some large dairy firms supply it, but it is cheaper to make it at home, and the above directions are easily carried out. When bought it is often sterilized and sold in air-tight bottles. It should be remembered that a long-continued diet of sterilized milk may, in children, cause scurvy rickets.

Milk, Peptonized.—(Not official.)

Preparation.—Take 25 grs. of Pulvis Pancreaticus Co. (B. P. C.), commonly known as peptonizing powder, and add it to 5 fl. oz. of tepid water in a flask, add to this a pint of milk previously warmed to 38°C., at which temperature the mixture should be maintained for half an hour; after this the flask should be transferred to a cold place until required for use. Peptonized milk should not be used after it has been kept more than 24 hours or after it has acquired a bitter taste. If metric quantities are used take 1·5 grms. of the powder, 125 mils water, and 500 mils milk.

Action and Therapeutics.

Peptonized milk is used in many conditions in which it is thought that the gastric digestion is too feeble to digest ordinary milk, or in which it is desired, as sometimes, for instance, in typhoid fever, to avoid the curdling of milk in the stomach. Milk or milk and egg should always be peptonized before being introduced into an enema.

Koumiss, or Kumyss.—(Not official.)

This is largely drunk by the Tartars, who prepare it by fermenting mare's milk. It may also be made by dissolving ½ oz. of grape sugar in 4 fl. oz. of water and 20 gr. of yeast in 4 fl. oz. of cow's milk. Pour both into a quart bottle, which is then filled up with milk, corked, wired, and put in a cool place and frequently shaken for four days.

Uses.

It contains a little alcohol and is extremely useful as a stimulant food in convalescence, in phthisis, and other conditions of exhaustion. It is often borne by the stomach when all other food is vomited. Several dairy firms sell it.

SUGAR OF MILK.

Saccharum Lactis.—Sugar of milk. *Synonym.*—Lactose, $C_{12}H_{22}O_{11},H_2O$. A crystallized sugar obtained from the whey of milk.

Characters.—Crystals or crystalline masses, greyish white, translucent, hard; scentless; faintly sweet; gritty when chewed.

Action and Therapeutics.

Sugar of milk is used as a vehicle for the trituration of powders, because being very hard it thoroughly divides them, and also it is but slightly deliquescent. For these reasons it is used as a diluent to get extracts to the required strength. It is employed to sweeten infants' food. As most patients

suffering from fever take milk diet, which is almost a starvation diet, and carbohydrates are particularly valuable in fever, for they are easily digested foods and spare the proteins of the body, ordinary milk may, in fever, be fortified by the addition of one, or if it does not disagree, two ounces of lactose to each pint.

OX GALL.

Fel Bovinum Purificatum.—Purified Ox Bile. The purified gall of the ox.

Source.—Evaporate fresh ox bile to one quarter its bulk. Wash thoroughly with alcohol (90 per cent.), distil off the alcohol. Evaporate what remains to the consistence of an extract.

Characters.—Yellowish green. Soluble in water and in alcohol. Taste partly sweet, partly bitter.

Dose, 5 to 15 gr.—3 to 10 decigrms.

Action and Therapeutics.

Ox gall has been used as a cholagogue purgative in cases of constipation in which the pale colour of the fæces indicates a deficient secretion of bile. An enema of 20 gr. (12 decigrms.) or more of it dissolved in an ounce or two of water is very useful in cases of impacted fæces, in which the rectum is so full that there is not sufficient room for a larger enema. It is a true cholagogue, for after absorption it passes to the liver, the secretion of which it considerably increases. Bile contains antitoxins ; thus the bile of venomous snakes is antidotal to their poison.

GELATIN.

Gelatinum.—The air-dried product of the action of boiling water on skin, tendons, ligaments, and bones.

Characters.—In translucent, almost colourless sheets or shreds. The solution in hot water is colourless and inodorous ; it solidifies to a jelly on cooling. It is insoluble in alcohol or ether. Its aqueous solution is precipitated by tannin.

Gelatin is a constituent of Suppositoria Glycerini and all Lamellæ.

Action and Therapeutics.

Gelatin is a hæmostatic, and has been given by the injection of a sterilized solution in normal saline fluid into the cellular tissue of the axilla in cases of hæmaturia, purpura, and to promote the formation of clot in aneurysms. Two hundred and fifty c.c. of a 1 per cent. solution may be injected every fourth day, or less of a 2 per cent. solution. The treatment is not to be recommended, for it may cause much pain, it often fails to stop bleeding or to cure the aneurysm, and it may cause hæmaturia. Gelatin often contains tetanus bacilli due to contamination from dirty hides, and fatal tetanus has frequently followed the injection of imperfectly sterilized gelatin; sometimes fatal symptoms resembling tetanus have resulted from the use of sterilized gelatin, these have been ascribed to emboli in the spinal cord. Gelatin is a useful basis for suppositories, pessaries, bougies, discs, gelatin capsules and lozenges, and as a coating for pills. Glycogelatin B. P. C. (gelatin, glycerin, sugar, citric acid, oil of lemon, orange flower water, carmine and water) is an excellent basis for throat pastilles. Each should weigh 30 gr. (2 grms.) Almost any drug may be incorporated in such pastilles. Medicated gelatin is often melted and painted on the skin in cutaneous affections.

LARD.

Adeps Præparatus.—Lard. The purified fat of the hog, *Sus scrofa*.

Composition.—(1) Olein, 60 per cent. (2) Stearin. (3) Palmitin.

Lard is contained in many ointments.

In India prepared suet should be employed in making the official preparations for which prepared lard is directed to be used.

Preparation.

Adeps Benzoatus.—Prepared lard, 1000; Benzoin in coarse powder, 30.

In India benzoated suet should be employed in making the official preparations for which benzoated lard is directed to be used.

ACTION AND THERAPEUTICS.

Lard is an emollient, and is used as a basis for ointments when it is wished that the active ingredient should be absorbed, for lard melts at the temperature of the body, especially if bandaged on. The benzoated variety has the advantage of not quickly turning rancid.

PEPSIN.

Pepsinum.—An enzyme obtained from the fresh and healthy stomach of a pig, sheep, or calf.

CHARACTERS.—A light yellow-brown powder, or pale yellow translucent grains or scales. Odour faint. Taste slightly saline. Very sparingly soluble in water or alcohol.

TEST.—Triturate 0·25 grm. pepsin with 1 grm. sodium chloride, add acidified water 1000 (0·65 per cent. of hydrochloric acid in water). Put in a flask 20 millilitres of the pepsin solution, add 12·5 grms. of freshly prepared coagulated white of egg rubbed through a fine sieve, triturate with 100 millilitres of acidified water. Keep the flask in a water bath at 41°C. for 6 hours. The white of egg should be dissolved, the solution being faintly opalescent. This shows that the pepsin has in 6 hours dissolved 2500 times its weight of coagulated white of egg.

Dose, 5 to 10 gr.—3 to 6 decigrms.

Preparation.

Glycerinum Pepsini.—Pepsin, 100; hydrochloric acid, 11·5; glycerin, 600; distilled water to make 1000. *Strength.*—1 fl. dr. represents 5·5 gr. of pepsin or 10 mils contain 1 grm.

Dose, 1 to 2 fl. dr.—4 to 8 mils.

ACTION AND THERAPEUTICS.

Pepsin may be given to help digestion in those rare cases in which from old age or long illness the secretion of pepsin is deficient, or it may be useful in convalescence from acute illnesses or in cases of cancer of the stomach, but it cannot aid the

digestion of fatty or carbohydrate food. It should be given directly after meals, and followed by a dose of hydrochloric acid in the proportion mentioned in the test. The pepsin should be tested before use, as many samples are inert. It is best given as Glycerinum Pepsini without additional hydrochloric acid.

Pepsin may be used to predigest albuminous food, either for administration by the mouth or the rectum. This is better than giving pepsin internally, for morbid processes may be going on in the stomach which prevent digestion. For predigestion Pulvis Pancreaticus Co. B. P. C. or Liquor Pancreatis (*q.v.*) is more reliable than pepsin. Predigested foods should be employed with judgment, for there is a likelihood that if artificial digestion be used too long the digestive functions of the stomach may atrophy. The rectum has no powers of digestion, and therefore many nutrient enemata and suppositories are predigested, but this is useless, for we now know that hardly anything but sugar can be absorbed from the rectum (*see* p. 616).

Preparations containing (*a*) pepsin with pancreatin and (*b*) pepsin with alkaline salts of bismuth are often ordered, but it must be remembered that in the presence of an acid pepsin destroys pancreatin, that in neutral solution pancreatin destroys pepsin, and that pepsin is immediately destroyed by alkalies.

The following directions for peptonizing meat may be followed. Take one pound of lean meat, pulp it finely, add six times its weight of water containing 0·2 per cent. of hydrochloric acid and 120 grains of pepsin. Digest at 47° C. in a porcelain digester for five or six hours with frequent stirring. Then neutralize with sodium carbonate, boil and filter. Evaporate the filtrate on a water-bath till it is of the consistency of a soft extract.

Peptonized meat suppositories are used, but no nourishment can be absorbed from them and they irritate the rectum.

PANCREATIC SOLUTION.

Liquor Pancreatis.—A solution of the digestive principles of the fresh pancreas of the pig. It is most active when the animal from which it has been obtained has been fed shortly before being killed.

Source.—Mix 250 millilitres alcohol (90 per cent.) and 200 millilitres of glycerin with water to produce 1000. Macerate 250 grms. of pancreas in this for 7 days.

Test.—If 3 millilitres with 0·2 grm. of sodium bicarbonate and 20 millilitres of water be added to 80 millilitres of milk, and the mixture kept at 45°C. for 1 hr., coagulation should no longer occur on the addition of nitric acid.

Dose, 1 to 2 fl. dr.—4 to 8 mils.

Action and Therapeutics.

Liquor pancreatis in the presence of alkalis has the power of converting starch into sugar, albumen and fibrin into peptones, and first curdling and then peptonizing milk. It will not act in an acid medium or above 47°C. The directions for peptonizing milk are given on p. 662. The Pulvis Pancreaticus Co. B. P. C. is a more convenient preparation than the Liquor as it contains sodium bicarbonate (pancreatin, 20; sodium bicarbonate, 80). It or liquor pancreatis and sodium bicarbonate used in the same proportions as in peptonizing milk will predigest farinaceous foods. It and bicarbonate of sodium or other preparations of pancreas are often taken by the mouth one to two hours after meals, but they are usually useless, being destroyed by the gastric juice.

Many pancreatized and peptonized foods are on the market, *e.g.* pancreatized emulsion of fat, pancreatized farinaceous food, peptonized chicken and beef jelly. These are often useful for those whose digestions are weak. Holadin capsules contain extract of the entire pancreas, and are given when it is suspected that the activity of the pancreas is deficient. It is supposed that the capsule is not

dissolved until it reaches the alkaline contents of the intestine. The treatment of diabetes by preparations of pancreas, other than insulin, has not proved successful.

Insulin.—(Not official.) A complex protein of unknown composition derived from the pancreas—usually of the ox. It is obtained by extraction of the substances soluble in alcohol 80 per cent., but insoluble in alcohol 93 to 95 per cent., and subsequent purification. It contains most of the anti-diabetic principle of the islets of Langerhaus, especially that of the β cells.

Insulin is, in some unknown way, essential to the use of carbohydrates by the tissues. When a healthy animal or man receives a dose of insulin, the sugar in the blood quickly diminishes from the normal of 0·12 per cent., and, if the dose has been sufficiently large, symptoms of hypoglycæmia supervene, *viz.*, weakness, faintness, failure of sight, depression of nervous reflexes and coma. In man these symptoms occur when the blood sugar has fallen to 0·06 or 0·05 per cent.

One unit of insulin is the amount which, on subcutaneous injection into a rabbit weighing 2 kilos, lowers its blood sugar to 0·045 per cent. The reason for this figure is that at this point the animal suffers from coma and convulsions as a result of the induced hypoglycæmia.

Insulin is of great use in diabetes, causing a rapid fall in the amount of blood sugar. The patient feels better, the sugar, acetone and acetoacetic acid in the urine rapidly decrease, lipæmia disappears, the symptoms of acidosis pass away, and the patient is able to take and utilize more food, including carbohydrates; hence he gains weight. Even if he is already in coma this may disappear.

Insulin is useless by the mouth. It is given subcutaneously as an aqueous solution. The usual dose for an adult is 10 or 15 units about a quarter of an hour before a meal, so that it will be able to exert its effect on the glucose which reaches the blood from the meal. Usually at least two doses a day are necessary, but the one in the evening should be smaller than that in the morning lest the insulin acting during the abstinence from food during the night should, reducing the sugar of the blood too low, produce the dangerous symptoms of hypoglycæmia. If these occur they can be got rid of by half an ounce of glucose or other sugar, in water, orally; or, if the patient is comatose, 5 per cent. solution of glucose may be given intravenously.

Insulin is not curative of diabetes, and therefore the treatment must be indefinitely long. To begin with, at any rate, it must not be given without determinations of the blood sugar, for some patients with glycosuria are not suffering from diabetes; and in diabetes innocens, in which the glycosuria is due to abnormal permeability of the renal cells for glucose, the blood sugar is always low and insulin easily causes dangerous hypoglycæmia. Further, in an ordinary case of diabetes estimations of the blood sugar at frequent intervals enable us to see the effect of the insulin, to arrive at the appropriate dose of it, and to determine how much food may be given. A case is being successfully treated when the increased blood sugar due to the disease is kept down to normal.

Trypsin.—(Not official.) The enzyme formed from the zymogen trypsinogen secreted by the pancreas.

Characters.—A white powder, changing proteins into peptones in an alkaline medium. It always contains some amylopsin and inert matter.

Dose, 3 to 10 gr.—2 to 6 decigrms.

A 5 to 10 per cent. cream, or suppositories, or pessaries, or solution in dilute glycerin, all made alkaline with sodium bicarbonate, have been used as an application to ulcerated malignant growths, because it has been suggested that the growth of cancer cells is due to an enzyme which acts in an acid medium, and therefore trypsin, which only acts in an alkaline medium, will neutralize this, but the benefit is doubtful. This suggestion has been carried further and it has been supposed that cancer enzyme can only act because in cancerous patients pancreatic secretion is deficient, hence trypsin with an alkali has been given internally in cancer but there is no proof that this does any good.

THYROID GLAND.

Thyroideum Siccum.—Dry Thyroid. A powder prepared from the fresh and healthy thyroid gland of the sheep.

Source.—Remove the fat and connective tissue directly the sheep is killed. Reject cystic, hypertrophied, or otherwise abnormal glands. Mince. Dry at 30°C. to 40°C. Powder the dried product. Remove all fat by washing with petroleum spirit and again dry.

Characters.—Light dull brown powder with faint meat-like odour and taste, and free from odour of putrescence. Liable to become damp and then deteriorates.

COMPOSITION.—The active principle is thyroxin, which contains 65 per cent. of iodine.

Dose, ½ to 4 gr.—3 to 25 centigrms.—in cachets.

ACTION.

Circulation.—Thyroid administered to man increases considerably the rate of the pulse, causes palpitation, enfeebles the cardiac beat, and makes the skin flushed and moist. Experiments on animals have failed to reveal the precise cause of this. The blood-pressure falls when a decoction of the gland is injected: the fall is vaso-motor, for the heart is not affected. Ordinary doses produce no effect on the blood except an increase in the number of lymphocytes.

Excretion.—The active constituents of thyroid gland are probably excreted entirely through the kidneys. Large doses may cause diarrhœa.

Metabolism.—The administration of thyroid leads to a greatly increased oxidation of all the tissues, consequently an excess of urea, uric acid, xanthin bases, and phosphates are excreted in the urine, and more carbonic acid by the lungs. It follows that thyroid rapidly reduces the body weight. One sixth of the loss comes from proteins, and five sixths from excessive oxidation of fats.

Kidney.—The quantity of urine is increased by giving thyroid, which may cause sugar and iodine in the form of iodides to appear in the urine.

Nervous system.—Occasionally a fine tremor, restlessness, and insomnia are caused by large doses.

THERAPEUTICS.

It is known that human beings whose thyroid is excised become myxœdematous, and that all sufferers from myxœdema have atrophied thyroid glands. If a preparation of sheep's thyroid is given to patients suffering from myxœdema, all the symptoms disappear, usually in about six weeks, although the patient's thyroid remains atrophied. The

effect is as striking as anything in medicine. It is best to begin with 5 gr. thrice a day, to gradually increase the dose till 10 gr. are given, and when all the symptoms have disappeared it will be necessary for about 10 gr. to be taken twice a week for the rest of the patient's life, to prevent recurrence. When the treatment was first introduced the glands were eaten, or transplanted under the skin, or the extract was administered subcutaneously; but equally good results are obtained by giving the liquor or the powder by the mouth; tablets of the powder are very convenient and much used. A diminution of certain goitres follows the giving of thyroid, but it is useless in exophthalmic goitre. Cretinism is also marvellously benefited, both mentally and bodily, by thyroid preparations, especially if given early in the patient's life. A few cases of imbecility in children, a few of climacteric insanity, and a few of tetany have been much improved by thyroid. Chronic psoriasis, which has resisted all other treatment, often disappears if the patient is put to bed and takes daily enough of thyroid preparations to keep him on the brink of poisoning by them, but unfortunately the disease often returns when the treatment is discontinued.

Thyroid preparations have been used for obesity, but the practice is not always to be recommended. They must be carefully given to those suffering from cardiac disorder.

Poisoning.—An overdose of a thyroid preparation causes an exaggeration of the effects already described. The most evident are a rapid pulse, slight pyrexia, headache, nausea, diarrhœa, restlessness, pains in the limbs, pruritus, and rarely delirium. These symptoms are termed 'Thyroidism'; it is said that the liability to them is lessened if arsenic be taken. If large doses be given to monkeys for a long period, a condition termed 'Chronic Thyroidism' is

produced. The symptoms of it are emaciation, muscular weakness, paresis, some alopecia, erection of some of the hairs on the head, proptosis, dilatation of pupils, widening of palpebral fissure, and death from asthenia. In some respects these monkeys resemble patients suffering from exophthalmic goitre.

Extracts of many other organs, *e.g.* bone-marrow and thymus (Thyminic acid known as solurol, a derivative of the nucleic acid present in thymus, is said, by possessing an affinity for uric acid, to prevent its deposition, and is therefore used in gout. Dose, 5 to 10 gr., usually given in a tablet), have been employed in medicine, but the only ones that are of any use are those of the thyroid, suprarenal pancreas and pituitary.

SUPRARENAL EXTRACT.

Adrenalinum.—Adrenalin is Dioxyphenylethanol methylamin, $C_6H_3(OH)_2 \cdot CHOH \cdot CH_2 \cdot NHCH_3$. It is lævorotatory (*Synonyms.*—Adrenine, Epinephrine, and Hemisine).

Source.—Obtained from the suprarenal glands of animals. It exists only in the medulla of the suprarenal gland.

Characters.—A light brown or nearly white, microcrystalline powder. Very slightly soluble in water; almost insoluble in alcohol, in ether, and in chloroform. Very unstable, rapidly destroyed in the body.

Preparation.

Liquor Adrenalini Hydrochloricus.—Adrenalin, 1; chloroform, 5; sodium chloride, 9; dilute hydrochloric acid, 3; distilled water to 1000. To be preserved in amber glass bottles.

Dose, 10 to 30 m.—6 to 18 decimils.

Action.

External.—Adrenalin has no action on the unbroken skin.

Internal.—It is so diluted by the gastro-intestinal contents and so rapidly destroyed that it

does not affect the stomach or intestines, nor is it absorbed as such from these.

It acts very quickly, both generally when injected into vessels or subcutaneously, and locally when applied directly to serous membranes and many mucous membranes, *e.g.* that of the nose.

Heart.—The heart is accelerated from stimulation of the accelerator myoneural junctions in the auricles and ventricles; the force of the systole is increased by direct action on the cardiac muscle. These effects and the rise of blood pressure are the same as, but much more powerful than, those of digitalis, but they only last a short while.

Vessels.—Small arteries (except the coronary, which are dilated) are constricted by direct action of adrenalin on the myoneural junctions in their muscular coat when the drug is in the blood; the constricting effect is most striking in the splanchnic area, because of this and the cardiac action the blood pressure rises considerably. Even large doses only slightly affect the vessels of the lungs, heart, and brain. This constriction is often very marked at the point of local application, *e.g.* when adrenalin is applied to mucous membrane of the nose.

Lungs.—It stimulates the sympathetic nerve-ends in the muscles of the bronchi and so causes dilatation of them.

Glands.—Adrenalin excites secretion by stimulating sympathetic nerve terminations. It acts chiefly on the salivary glands and those of the mouth; not at all on the sweat glands. Atropine is antagonistic to it. Adrenalin acting on sympathetic endings in the liver produces glycosuria, due to the rapid conversion of glycogen into glucose.

Unstriped Muscle.—Much of this, besides that of the arterioles, is contracted by the action of adrenalin on nerve terminations, *e.g.* that of uterus, especially in pregnancy, vagina, vas deferens, vesiculi seminales. The same peripheral effect leads to dilatation

of the pupils, retraction of the nictitating membrane, and protrusion of the eye. The ileo-colic sphincter is contracted, but the rest of the intestine is dilated.

Adrenalin thus has a specific stimulant effect on the myoneural junctions of the nerves of the sympathetic system, a result abolished by administering ergotoxine. It is destroyed in the body, so that its effects rapidly pass off.

Therapeutics.

Because of its powerful local vaso-constrictor action an aqueous solution of adrenalin—of a strength of 1 in 1000—is locally applied as a hæmostatic with great advantage in many conditions such as epistaxis, hæmorrhage from the uterus, before operations on adenoids, turbinated bones or piles. For these purposes it may be used as gauze plugs soaked in the 1 in 1000 solution, or as a spray (1 in 2500), or as a suppository (10 ♏ of 1 in 1000 solution in each). It may be introduced into the bladder before operations on it, or again it may be given for hæmatemesis (5 to 30 ♏, 3 to 18 decimils, of 1 in 1000 solution), but it is of little use here as it is much diluted by the gastric contents. Applied with cocaine or eucaine it may be used for painless, bloodless operations on the eye and other parts (*see* pp. 431–434). Adrenalin has very great power to contract the uterus, whether pregnant or non-pregnant, and it may be used for the interior of the uterus in the same way as for the nose.

As adrenalin is rapidly destroyed in the intestines it can only be given for its remote effects hypodermically or intravenously.

Thirty minims of a 1-in-1000 solution of adrenalin may be injected subcutaneously in cases of shock or any form of sudden cardiac failure, for in animals the heart may be completely resuscitated by this method even when the circulation has apparently ceased, but clinically adrenalin is of less use

as a cardiac stimulant than might be expected, for its effects pass off very quickly. As a circulatory restorative pituitary extract is clinically far superior as its effects last longer. Occasionally subcutaneous abscesses follow subcutaneous injection. Therefore some preparation sold in sealed sterilized phials (*e.g.* Hemisine) should be used. Hemisine is standardized physiologically by observation of its effects on blood pressure.

Adrenalin, by its action on the bronchi, is most efficacious in stopping a paroxysm of asthma. Five or ten minims of the Liquor injected subcutaneously will often do this in a few seconds. It is valueless for Addison's Disease.

Toxicology.

Fatal doses of adrenalin lead to two varieties of changes seen *post mortem*. Its action on the blood pressure leads to congestion of the viscera, hæmorrhages and serous effusion. These changes are well seen in the kidneys, liver, and lungs. Their occurrence in the last-named causes œdema of the lungs and filling of the air vesicles with blood; hence the animal dies of asphyxia. Consequently adrenalin should never be given for hæmoptysis. The other toxic changes, seen chiefly in the cells of the liver and kidneys, are due to the fact that adrenalin is a protoplasmic poison. Owing to the action on the liver, there is a great fall in the output of urea.

Pituitary Extract.—(Not official.)

This is prepared from the posterior or infundibular lobe of the pituitary body of the sheep.

Dose.—Usually given subcutaneously in doses of 1 c.c., corresponding to 3 grains of the posterior lobe. Sterilized solutions in glass capsules, called vaporoles containing 1 c.c. and 0·5 c.c. in each, are sold.

Action.

Pituitary extract has little effect when given by mouth, and the following account applies to subcutaneous or intramuscular injection. When given thus it acts so quickly that it is rarely necessary to give it intravenously.

Circulatory System.—The heart is slowed partly

from the effect on the vagus, partly from that on its muscle. The force of the beat is increased. There is a great rise of blood-pressure due somewhat to the cardiac effect, but chiefly because the drug constricts arterioles by acting on their muscular coat.

Kidneys.—The renal arterioles are not constricted but dilated, and therefore there is an abundant secretion of urine, but this is also due in part to a direct stimulation of the renal cells. The diuresis is followed by considerable decrease in the urinary flow.

Pituitary extract has a remarkable effect in increasing the flow of milk, due entirely to a stimulation of the plain muscle in the mammary gland.

Uterus.—Pituitary extract causes this to contract strongly from a direct effect on the muscle, acting best if parturition has commenced.

Intestines.—The muscle of these, too, is stimulated, often very powerfully.

The muscle of the bladder is also contracted, and the pupil dilates. The flow of cerebro-spinal fluid is increased.

Therapeutics.

Pituitary extract is an admirable circulatory stimulant, acting within a minute or two of injection. It is of great use in cardiac failure during severe operations, and to a less extent in severe fevers, *e.g.*, pneumonia when the pulse is failing; indeed, it may be used for cardiac failure due to any cause. The good effect soon passes off, but it lasts much longer than that due to adrenalin. It may be tried as a diuretic, but does not act so well when the kidneys are diseased as when they are healthy. It lessens the flow of urine in diabetes insipidus. It is much used instead of ergot to produce uterine contraction whenever that is required, and is occasionally very useful in severe constipation and to get the bowels to act

after operations, sometimes they are opened instantly when everything else has failed. It has also been given to promote the secretion of milk. Its action suggests that it may prove to be of value in exophthalmic goitre. It does not benefit sufferers from acromegaly. Paralysis agitans and osteomalacia are both said to be improved by pituitary extract. If a second injection is given, it should be several hours after the first, for a second injection quickly following a first often produces collapse.

The extract, which is previously standardized physiologically by its action on the uterus, is a fluid of which the dose is 0·5 to 1·0 c.c. injected subcutaneously. It is sold in hermetically sealed bulbs called "Vaporoles," each containing a single dose. As only the infundibular part of the gland is used it is ordered as "Vaporole Infundin."

SPERMACETI.

Cetaceum.—Spermaceti. A solid wax obtained from the sperm whale, *Physeter macrocephalus*.

CHARACTERS.—Crystalline, pearly white, glistening, translucent masses with little taste or odour. *Solubility.*—Not in water, but soluble in ether, chloroform, or boiling alcohol.

COMPOSITION.—It is cetylic alcohol, $C_{16}H_{33}OH$, in combination with palmitic acid, $HC_{16}H_{31}O_2$, forming a fat, cetin, $C_{16}H_{33},C_{16}H_{31}O_2$.

Preparation.

Unguentum Cetacei.—Spermaceti, 20; white beeswax, 8; liquid paraffin, 72.

ACTION AND THERAPEUTICS.

Spermaceti is used as an emollient and as a basis for ointments.

COD-LIVER OIL.

Oleum Morrhuæ.—The oil expressed from the fresh liver of the cod, *Gadus morrhua*, by a heat not exceeding 85°C. and from which the solid fat has been separated by filtration at —5°C. Norway coast.

CHARACTERS.—Pale yellow, with a slight fishy odour, and a bland fishy taste. Sp. gr. 0·920–0·930.

COMPOSITION.—The chief constituents are—(1) *Olein* (85 per cent.), which is a fluid fixed oil, and is oleate of glyceryl, $C_3H_5(C_{18}H_{33}O_2)_3$. (2) Palmitin, myristin, and stearin (10 per cent.). (3) Free fatty acids, as oleic, palmitic, stearic. (4) Trimethylamine. (5) Traces of iodine, bromine, bile salts, cholesterin, sulphuric acid and phosphoric acid. (6) Many alkaloids. Gaduin, which has been described, is probably a decomposition product. The composition of the morrhuol of commerce is uncertain.

Dose, 1 to 4 fl. dr.—4 to 16 mils.

ACTION.

External.—Cod-liver oil is a bland unirritating oil. If it is desired to administer it in cases in which it is rejected by the stomach, it may be rubbed into the skin. The oil is certainly absorbed when applied in this way.

Internal.—*Gastro-intestinal tract.*—Cod-liver oil, even more than other oils, is liable to cause indigestion, nausea, and sickness. Large doses may set up diarrhœa. It is more readily absorbed than other oils. Loops of intestine have been isolated in the lower animals, and into each loop different oils have been injected. The intestines are returned to the abdominal cavity, and after some time the animal is killed and the loops are opened. It is always found that cod-liver oil has been more rapidly absorbed than any other oil. The facility with which cod-liver oil is absorbed is also shown by the fact that it often cannot be recognised in the fæces, although equal quantities of other oils taken by the mouth are passed unaltered. Some authorities believe that the superior absorbability of cod-liver oil depends upon the biliary principles contained in it, but this is doubtful; others think that it is because the presence of free acids facilitates saponification and emulsion. Certainly it contains more free fatty acids than other oils, and it also emulsifies much more easily.

Tissues.—Not only is cod-liver oil more readily absorbed than other oils, but it is a better

food. All oils lead to an increased formation of fat, but cod-liver oil is the most powerful. It reduces the colour of a solution of permanganate of potassium more readily than other oils—that is to say, it is more readily oxidized. Thus, as it is more easily absorbed and more easily oxidized, we have a partial explanation of its peculiar value in increasing the weight of the body; but the general belief is that these two facts do not wholly explain its action, and that it has some peculiar specific action, especially upon those suffering from phthisis or rickets, for whom it may be an excellent drug. Some consider that its undoubted value is due to high proportion of vitamine A in it.

Therapeutics.

External.—The smell of cod-liver oil is so disagreeable that it should not be rubbed in externally unless this treatment be absolutely necessary.

Internal.—Cod-liver oil is of great service in all varieties of tuberculous disease, the only contra-indications being high temperature, severe hæmoptysis, and dyspepsia, vomiting, or diarrhœa whether primary or induced by the oil. Patients often improve in every way under its influence, and it has been shown to benefit tuberculous animals. With the same limitations it may be administered with great advantage in rickets, and in any chronic disease associated with loss of flesh, such as long-continued suppuration, convalescence from acute disease, tertiary syphilis, and starvation. It often is of benefit in the chronic bronchitis and the chronic eczema of childhood. It is frequently given with success in neuralgia, general feebleness, despondency, and other nervous conditions. Many persons cannot, or imagine they cannot, take it on account of its nasty taste. There are in the market several preparations of cod-liver oil in which, by careful preparation, the disagreeable taste is almost abolished. Ten minims

of pure ether with a drop or two of oil of peppermint or cloves will, when mixed with a dose of cod-liver oil, often render it more palatable. Sometimes it is taken in capsules, or made into a jelly with isinglass, or a little salt is put into the mouth after the oil is taken, or the mouth is rinsed out with brandy beforehand. Sometimes it is taken in coffee, or with orange juice, but the best way is to form an emulsion, for experiments have shown that the body utilizes it much better when given as an emulsion. A very nutritious one is made by rubbing together equal parts of maltine and cod-liver oil, and in this the oil can hardly be tasted.

The B. P. C. has various useful emulsions of cod-liver oil, *e.g.* Emulsio Olei Morrhuæ (B. P. C.), in which it is emulsified with acacia and flavoured with oil of bitter almonds, Emulsio Olei Morrhuæ cum Ferro (B. P. C.), which is the last mentioned with iron and ammonium citrate added, and Emulsio Olei Morrhuæ cum Glycerophosphatibus (B. P. C.) There are several others. The dose of all is 2 to 8 fl. dr. (8 to 30 mils).

Subcutaneous, intramuscular, and intravenous injections of a 3 p.c. solution of sodium morrhuate in doses of ½ to 4 c.c. thrice weekly have been used for tubercle and leprosy and are supposed to be directly destructive to the bacilli.

Ammonii Ichthosulphonas.—(Not official.)

Source.—A bituminous quartz containing the fossil remains of fish and other animals is subjected to destructive distillation, the resulting oily product is called ichthyol. It is a viscid, brownish, almost black substance with a tarry odour and containing 10 per cent. of sulphur. Ammonium Ichthosulphonate consists of the ammonium salts of the sulphonic acids prepared from ichthyol.

Characters.—A blackish-brown viscid liquid with a powerful characteristic odour.

Dose, 15 to 30 gr.—1 to 2 grms., in capsules.

Action and Therapeutics.

Ammonium ichthosulphonate is chiefly used externally for chronic eczema and psoriasis. An ointment with lanolin

and ammonium ichthosulphonate 10 per cent. (Unguentum Ichthamolis B. P. C.) is easily made. Unna's Ichthyol paste (starch 40, moisten with water 20, rub in ammonium ichthosulphonate 40, and add strong solution of albumen 1 or 1½) is recommended for acne rosacea. Pasta Ichthamolis B. P. C. is a good preparation. Ichthyol has been given as a pill or in capsules thrice a day for chronic rheumatism.

HONEY.

Mel Depuratum. *Synonym.*—Purified honey.

SOURCE.—Melt honey in a water-bath, and strain through warm flannel while hot. Sp. gr. 1·36.

Preparation.

Oxymel.—Purified honey, 500; acetic acid, 100; water, 100. Sp. gr. 1·27.

Dose, 1 to 2 fl. dr.—4 to 8 mils.

Purified honey is contained in Confectio Piperis, Oxymel Scillæ, and Mel Boracis.

ACTION AND THERAPEUTICS.

Honey is demulcent, relieving dryness of the mouth and facilitating swallowing. Oxymel is a useful preparation. It is a common ingredient of cough mixtures. Honey is a mild laxative, and may be given to children for this purpose.

WAX.

Cera Flava.—Yellow Beeswax. Prepared from the honeycomb of the hive bee, *Apis mellifica.*

CHARACTERS.—Firm, yellowish. Odour honey-like. Not unctuous. Soluble in oil of turpentine, not in alcohol. It is much adulterated with flour and paraffin.

COMPOSITION.—It consists chiefly of (1) Myricin (Myricyl palmitate) $C_{30}H_{61}C_{16}H_{31}O_2$, 80 per cent. (2) Cerotic acid.

Cera Alba.—White Beeswax. Made by bleaching yellow beeswax.

USES.

Yellow and white wax are only used as basis for many plasters and ointments, and for Pilula Phosphori.

COCHINEAL.

Coccus.—Cochineal. The dried fecundated insect *Coccus cacti.*

CHARACTERS.—Oval, flat or concave beneath, convex above, about 5 millimetres long, transversely wrinkled, purplish black or purplish grey, easily pulverized, the powder being dark red or puce-coloured.

COMPOSITION.—The chief constituent is the glucoside *carminic acid*, $C_{17}H_{18}O_{10}$. Sulphuric acid and several other reagents precipitate from the decoction the well-known colouring matter carmine.

Preparation.

Tinctura Cocci.—Cochineal, 1; alcohol (45 per cent.), 10. Macerate.

Dose, 5 to 15 m.—3 to 10 decimils.

Cochineal is contained in the compound tinctures of cardamoms and cinchona.

USES.

Cochineal is only used as a colouring agent.

CANTHARIDINUM.

Cantharidin. $C_{10}H_{12}O_4$. — May be obtained from various species of Cantharis (Spanish Fly) or of Mylabris. Both are beetles.

CHARACTERS.—Colourless glistening crystals, inodorous. Very slightly soluble but most soluble in fixed oils.

Preparations.

1. Acetum Cantharidini.—Cantharidin, 1; glacial acetic acid, 200; acetic acid, to produce 2000.

This is about the same strength as Acetum Cantharidis B. P. 1898.

2. Emplastrum Calefaciens. — *Synonym.*—Warming Plaster. Cantharidin, 0·2; chloroform, 20; olive oil, 40; resin plaster, 940.

This contains 0·02 per cent. of cantharidin, being almost the same strength as Emplastrum Calefaciens B. P. 1898.

3. Emplastrum Cantharidini.—Cantharidin, 2; chloroform, 100; yellow beeswax, 450; wool fat to 1000.

This contains 0·2 per cent. of cantharidin, being almost the same strength as Emplastrum Cantharidis B. P. 1898.

4. Liquor Epispasticus. — Cantharidin, 4; castor oil, 25; resin, 12; acetone to 1000.

This is approximately the same strength as Liquor Epispasticus B. P. 1898.

5. Collodium Vesicans. — Pyroxylin, 25; Cochineal, 10; Liquor Epispasticus to 1000.

6. Tinctura Cantharidini.—Cantharidini, 0·1; chloroform, 10; alcohol (90 per cent.) to 1000.

Dose, 2 to 5 m.—12 to 30 centimils.

This is approximately the same strength as Tinctura Cantharidis B. P. 1898.

7. Unguentum Cantharidini.—Cantharidin, 0·1; chloroform, 10; benzoated lard, 290.

This contains 0·033 per cent. of cantharidin and is two-thirds the strength of Unguentum Cantharidis B. P. 1898.

In India benzoated suet should be used instead of benzoated lard.

Action.

External.—Cantharidin is a **powerful irritant,** but it is slower in its action than most. If any of its preparations is applied to the skin no effect is noticed for two or three hours; then a tingling burning pain is perceived. Soon the part becomes red from vascular dilatation, the drug now producing its rubefacient effect. The next stage is the formation of several vesicles. These soon run together to form one large bleb full of clear serum. Not only is cantharides thus an **irritant and vesicant,** but it is a powerful **counter-irritant,** probably dilating by reflex action the vessels of the deep-seated organs under the point of application.

Cantharidin can be absorbed by the skin in sufficient quantity to produce internal effects.

Internal.—Cantharidin is hardly used internally in medicine, as it is such a powerful irritant.

Gastro-intestinal tract.—It produces severe gastro-intestinal irritation, the patient suffering

from abdominal pain, diarrhœa, and vomiting, even if the drug is injected subcutaneously, showing that it is excreted by the gastro-intestinal mucous membrane. There may be a burning pain in the throat; the motions and vomited matters may contain blood. These symptoms naturally cause much general depression.

Genito-urinary tract.—Cantharidin is absorbed into the blood, and a few hours after the gastro-intestinal symptoms have set in the patient complains of great pain in the loins and strangury—that is to say, there is an urgent desire to micturate; the effort is very painful from vesical tenesmus, and the quantity of urine passed is very small; it may contain albumen and blood. In severe cases of poisoning there may be greatly increased sexual desire, numerous seminal emissions, violent priapism, with swelling and heat of the genital organs. In women cantharides may cause abortion or induce menstruation.

Post mortem.—Intense gastro-intestinal inflammation is present, consequently swelling, ecchymoses, and hyperæmia of the mucous membrane of the alimentary canal are observed. The kidneys are found to be very congested and in the early stage of acute nephritis. There is also much inflammation of the genito-urinary mucous membrane.

THERAPEUTICS.

External.—Cantharidin is very largely employed to raise a blister, and it is of all drugs the most commonly used counter-irritant. It is applied to the chest in pleurisy, over the pericardium in pericarditis, over the inflamed nerves in neuritis, over the mastoid process in disease of the ear, over joints with chronic effusion into them and over the stomach when there is gastric pain or vomiting. A blister

applied over the nerve will often relieve pain in neuralgia. After the blister formed by cantharidin has burst some bland ointment should be applied. The cantharidin preparation should not be left on after the development of the bleb, lest the cantharidin should be absorbed. Cantharidin should not be applied to a part on which the patient lies, or a bedsore may form; nor must it be used in renal disease; and it should be carefully employed in children or debilitated persons. It ought not to be applied to paralysed limbs.

Cantharidin is the basis of many preparations the object of which is to stimulate the growth of the hair, such as the following, Acetum Cantharidini, ½ fl. oz. (15 mils); Glycerin, ½ fl. oz. (15 mils); Spiritus Rosmarini, ½ fl. oz. (15 mils); Water, 5 fl. oz. (150 mils).

Internal.—The drug is rarely given internally.

LEECHES.

Hirudo.—The Leech. Two species are official: (1) *Hirudo medicinalis*, the speckled leech (belly greenish yellow, spotted with black); (2) *Hirudo quinquestriata*, the green leech (belly olive-green, not spotted).

Characters.—Body soft, smooth, five or more centimetres long, tapering to each end, plano-convex, wrinkled transversely with 90 to 100 fine annulations. Anterior extremity has small sucker with triradiate jaws, posterior extremity a large sucker. (1) Speckled Leech: dorsal surface olive-green, six longitudinal stripes, ventral surface greenish-yellow with black spots. (2) Five-striped Leech: dorsal surface greenish-brown, with five longitudinal stripes; ventral surface greenish yellow not spotted. A good specimen will remove 1–2 fl. dr. of blood.

Action and Therapeutics.

Leeches are used to remove blood. They are usually applied over deep-seated organs when they are congested, and great relief is often afforded.

For example, three or four leeches over the liver when that organ is enlarged in heart disease, or one or two behind the ear when the tympanic cavity is inflamed, frequently do good. The leech being applied to the skin, the animal fixes itself by its sucker-like disc, makes a triradiate cut with its mouth, and draws into its body, which consequently becomes swollen, about a drachm and a half of blood. If this is not sufficient, a hot fomentation put on after the animal is removed may increase the quantity to half a fluid ounce. The skin should be well washed with a little milk before the leech is applied. Occasionally the hæmorrhage requires pressure or some local styptic, as adrenalin, to stop it. If leeches have to be applied to the mouth, rectum, or uterus, leech glasses, which allow only the head to protrude, should be used.

Diphtheria Antitoxic Serum.—(Not official.)

When the bacillus of diphtheria grows in the body it produces toxins, albumoses, and an organic acid, and provokes the formation of a substance (called an antitoxin) which is found in the blood. This antitoxin is an antidote to the toxin of the diphtheria bacillus, it is largely owing to the production of it that the patient is enabled to survive, and his chances of surviving are enhanced if antitoxin is administered to him to aid that which is formed in his body.

Source.—Diphtheria bacilli are grown in a flask containing some nutrient broth (*e.g.* meat broth), to which 0·5 per cent. sodium chloride and 2 per cent. commercial peptone have been added. At the end of some weeks the bacilli are filtered off, and the fluid left contains a large amount of diphtheria toxin, which should be at least of such a strength that $\frac{1}{10}$ c.c. of it will kill a good-sized guinea-pig. From $\frac{1}{5}$ to 1 c.c. of it is aseptically injected into the jugular vein of a horse: this produces slight symptoms. As soon as they are past a larger dose is injected, and so the dose is gradually increased until 500 c.c. or more are given at each injection. This leads to the formation of a large amount of antitoxin in the blood serum. At the end of some months the horse is aseptically bled to 8 litres into a sterilized vessel, the blood coagulates, and the antitoxic serum is put into sterilized

bottles and hermetically sealed, a little carbolic acid or other antiseptic being added to prevent decomposition.

The details may be modified, as horses vary in their reaction to the toxin, and toxins vary in strength, but the essentials of the method always remain the same.

Mode of Administration.—The antitoxic serum has been shown to be useless when given by the mouth, perhaps because it is destroyed in the liver. Therefore it is always injected subcutaneously; usually between the shoulders or on the side of the abdomen. Before injection the skin should be thoroughly washed with an antiseptic, and all ordinary antiseptic precautions should be taken. After injection the puncture should be sealed with antiseptic gauze, iodoform and collodion. The antitoxin for each injection should be taken from a fresh bottle. A special syringe, so constructed that all the parts of it can be boiled before use, is employed. It is best made entirely of glass. The barrel and piston should be boiled separately or else they may crack. It should hold 10 c.c. The needle is 2 or 3 inches long. It should be fine, as then the puncture is less painful. Both needle and syringe should cool before use, or the antitoxin may coagulate.

Dose.—It is better to give a small dose of a concentrated than a large dose of a dilute antitoxin; but the initial dose should be large (for an infant 2000 units, for an older patient 3000 or 4000), so as to quickly neutralize all the toxin. If the illness has lasted more than twenty-four hours larger doses should be given. The antitoxin should be as fresh as possible. All antitoxins deteriorate by keeping. The strength, which is stated on the bottle, varies between 200 and 2500 units per cubic centimetre, but usually it is about 500. The antitoxin must be obtained from a reliable source, and the more concentrated is to be preferred, for probably some of the ill-effects that occasionally follow are due to the serum of the horse with which the antitoxin is mixed. The quantity given should be such that from 4000 to 12,000 units or even more are injected in the first twenty-four hours after the patient comes under treatment. This amount may be divided into two or three doses, and should be repeated on the second and third days if necessary, but as far as possible a single sufficient dose is better than several smaller doses. A unit is the smallest quantity of antitoxic serum which, when mixed with a certain quantity of a standard diphtheritic toxin and with it injected into the subcutaneous tissue of a healthy guinea-pig weighing from 250 to 300 grammes, protects the animal from death within four days.

It is impossible in a work like this to give a more precise definition, for all diphtheritic toxin consists of toxin proper, which is poisonous, and toxoid bodies which although not poisonous will neutralize the antitoxic properties of antitoxic serum. Therefore to standardize antitoxic serum it must be *tested against diphtheritic toxin in which the proportion of* toxins proper and toxoids and the neutralizing activity of the latter as regards antitoxin are all known and constant. Such a standard toxin was originally kept in the Government testing department at Frankfort-on-the-Main, and the strength of all diphtheritic antitoxins should be expressed in terms of it or standards derived from it.

Action and Therapeutics.

Antitoxic serum diminishes all the symptoms of diphtheria, and in particular it greatly lessens the liability to sudden cardiac failure. If the diphtheria toxin be administered to animals fatty degeneration of the heart is found after death, but if they have also had antitoxin this is absent. Both clinical and experimental evidence shows that after antitoxin is given, although the bacilli continue to exist in the throat, the formation of membrane ceases and that which is present rapidly disappears; therefore laryngeal diphtheria rarely follows faucial if antitoxin is used early, the patient becomes less anæmic, his pulse improves, and his temperature may fall a little, although this is less influenced by antitoxin than are the other symptoms of diphtheria. The maximum effect of the antitoxin is not seen till twenty-four hours after injection. All reliable collections of cases show that the mortality, especially in children, is much less when the antitoxin is used. It should be given at the earliest possible moment, even if it is only likely that the patient is *suffering from diphtheria, for the number of fatal* cases is less when antitoxin is used early in the illness. The benefit is more marked in laryngeal than in other varieties of diphtheria, the mortality of tracheotomy cases falling by one half. The frequency of the occurrence of paralysis is not diminished, but the

percentage of recoveries in cases with paralysis is slightly increased. When a case of diphtheria is discovered in a school, the other children who have been associated with the patient should have 500 units given to each as a preventive. The protection conferred lasts about three weeks. Such preventive treatment is especially useful for any suffering from measles or scarlet fever, for in both these diphtheria is a dangerous complication.

Poisoning symptoms are sometimes seen after any antitoxic serum has been given, but they are usually unimportant and very rarely severe. When they are present the patient is said to be suffering from anaphylaxis. They are not due to the antitoxin, but to some other constituent of the serum, for they may follow when the simple serum of animals is injected into the human subject. The most common is a rash, met with in about 35 per cent. of the patients injected; it may appear as late as the end of the third week after injection, but it is usually seen at the end of the first week. In a few cases a second rash is observed after the first has faded. Usually it is a mere erythema, but it may be papular or urticarial. Commonly it disappears in three days. Pains in the joints and slight swelling of them are occasionally present, and sometimes slight pyrexia is seen. These symptoms are most likely to appear if a second dose is given, even if it is quite small. It is said that they may often be benefited by 15 gr. of calcium lactate three times a day by the mouth.

Meningococcic Antitoxic Serum.—(Not official.)

Epidemic cerebrospinal meningitis is caused by the diplococcus meningitidis. Horses are repeatedly injected with various strains of this bacillus. At the end of four or five months their serum is sufficiently antitoxic to be of use. Some cerebrospinal fluid is withdrawn from the patient by lumbar puncture and is replaced by 15 to 30 c.c. of the serum repeated daily till the patient recovers. This serum not only acts as an antitoxin, but it destroys the offending micro-

organisms. Its use has very greatly diminished the mortality of cerebrospinal fever in many epidemics, but it was not of much value during the English epidemic of 1914–15. This was partly because the large sudden demand for it led to the putting on the market of imperfectly prepared serum, but chiefly to the fact that the success of the serum depends upon its being made from the same strain of meningococcus as, in any particular case, causes the disease. To obtain the best results it must be given early.

Tetanus Antitoxic Serum.—(Not official.)

This is prepared on the same principles as diphtheria antitoxin (*q.v.*). We know that the tetanus toxin links itself closely to the proteins of the cells of the central nervous system, and that when it passes from a wound to the central nervous system it travels along the protoplasm of the nerves. Unfortunately this linking takes place almost coincidently with the appearance of symptoms, and when once the linking has occurred no amount of antitoxin can dislocate it. Hence antitoxin, to be any use, must be given directly the earliest symptoms show themselves. It has been injected directly into the brain in the hope that it may meet and neutralize the toxin before that reaches the nerve cells, or perhaps unite with the cells and thus prevent the toxin from doing so. A small cut is made down to the bone, which is bored with a drill, and the antitoxin is directly injected into the cerebrum with a blunt needle. It is also given subcutaneously, intravenously, directly into the nerve from the wound, and intrathecally, and this certainly seems to be the best; injection into the brain is rarely done now. No very striking success has attended its use in man, perhaps because tetanus is not usually diagnosed till long after infection, and perhaps because, as just pointed out, the tetanus toxin is soon very firmly united with the proteids of the central nervous system; but it is well to give the intrathecal treatment a trial, using as much as 5000 units for a dose frequently repeated, and if there is any likelihood that the toxin is still being absorbed from the wound, 10,000 units may be given from time to time intravenously.

There is however a certainty that it may benefit if it is given directly after a patient has a wound which is likely to contain tetanus bacilli, *i.e.* such a wound as is contaminated with soil. In the late war English soldiers received as a preventive 500 units subcutaneously as soon as possible after the infliction of a wound, followed by three similar doses at intervals of a week, and there is every ground for believing

that this practice is the reason why the deaths from tetanus are few as compared with other wars.

Antipneumococcic Serum.—(Not official.)

This is prepared in the same way as antistreptococcic serum (p. 693), and like it is bactericidal, not antitoxic. It has been used for diseases due to the pneumococcus, but the evidence of its efficacy is very slight.

Antivenomous Serum. – (Not official.)

The only antitoxic serum against snake-bite that is sold is the antivenene prepared by Calmette. It is made from the horse in the same way as diphtheria antitoxin. It is antitoxic to cobra poison, and is in practice efficacious; probably it is useless for bites by other snakes, but as this is uncertain it should always be given. The serum that is much wanted is a polyvalent one, efficacious for bites by all species of poisonous snakes. Antivenomous serum is given hypodermically.

Antithyroid Serum. – (Not official.)

This is the blood serum of rams upon whom thyroidectomy has been performed six weeks previously. It is usually known as Moebius's Antithyroid Serum. The dose is 5 ♏ (3 decimils) increased to 30 ♏ (18 decimils) thrice daily by the mouth. It is given for exophthalmic goitre. This treatment hardly appears to benefit the disease. Rodagen is a white powder consisting of the dried milk of goats whose thyroid has been removed. Milk sugar is added as a preservative. It has been tried for exophthalmic goitre – about 100 grains (7 grms.) a day is given.

Hay Fever Antitoxin.—(Not official.)

Hay fever is due to a toxin contained in the pollen of rye and other grasses. It is soluble, and is thus dissolved by the nasal secretions. Dunbar, by inoculating rabbits, prepared an antitoxin to it. This antitoxin is now made by inoculating horses. It is called pollantin. Immediately the sufferer from hay fever feels an attack coming on he applies a drop or two of the antitoxin with a pipette to the eye or nose. This treatment often cuts short the disease.

Antidysenteric Serum.—(Not official.)

This has been prepared by inoculating a horse with various strains of Shiga's or Flexner's bacillus. It certainly seems to be of use in the treatment of bacillary dysentery, using the serum corresponding to the bacilli causing the disease, but it is of course useless for amœbic dysentery for which dose we have a specific in emetine (q.v.). Usually 20 to 40 c.c. are given subcutaneously for two or three days.

Antiplague Serum.—(Not official.)

This is prepared by inoculating a horse with plague bacilli. Its action is bactericidal as well as antitoxic. It appears to do good in some cases. Usually 50 c.c. are given intravenously, followed by two doses of 50 c.c. subcutaneously in 24 hours and smaller doses during the next few days.

Antistreptococcic Serum.—(Not official.)

Streptococci do not cause the septic diseases due to them by developing a toxin which circulates in the blood, but by being themselves carried all over the body, which attempts to kill them by developing specific bactericidal bodies fatal to them. To prepare antistreptococcic serum the virulence of streptococci is increased by their passage through several rabbits; they are then grown on a medium which preserves their virulence. A horse is next treated with successive doses of cultivations of these living streptococci, each more potent than the former. At the end of a year the serum of the horse is toxic enough to streptococci for use. The dose varies with different specimens of serum. It is always given subcutaneously.

Antistreptococcic serum suggests itself as useful for those diseases which are principally due to infection by streptococci. Such are malignant endocarditis, erysipelas, surgical septicæmia, disease of the middle ear, thrombosis of the lateral sinus, and puerperal septicæmia. A few successful cases have been recorded of its use in these disorders, but the disappointments have been so numerous that it is doubtful whether it does good. One great disadvantage of it is that cultivations from different sources of apparently identical streptococci vary so widely in their properties that serum which is bactericidal to one cultivation is not to another. This difficulty may, to some extent, be overcome by using one of the polyvalent sera on the market.

Coley's fluid, a mixture of the toxins of streptococcus erysipelatosus and bacillus prodigiosus, has been injected for sarcoma and carcinoma, as these growths sometimes lessen after an attack of erysipelas, and occasionally it does real good.

Streptococcic Vaccine.—(Not official.)

When a patient suffers from a disease due to bacteria and recovery ensues, this is because various substances, called anti-bodies, are already present or are developed in his blood, which are harmful to the bacteria (*e.g.* agglutinins, which cause clumping of them; bacteriolysins, which destroy them), or antagonize the toxins produced by them, and to the fact that the phagocytes in his blood destroy

the bacteria. The ability of the phagocytes to destroy the bacteria is believed to be exalted by the development in the blood of certain substances called opsonins (*see* "Tuberculin," p. 695), which render the bacteria particularly vulnerable to the phagocytes. Often the patient fails to get well because his power of developing these modes of resistance is not sufficient. In such a case it sometimes appears that by injecting subcutaneously into the patient dead bacteria of the variety causing his disease his various modes of resistance are exalted, and thus recovery is hastened. A preparation of bacteria used for such a purpose is called a vaccine, and the dose is expressed as the number of bacteria injected—*e.g.* we speak of a dose of 5,000,000 of streptococcal or gonococcal vaccine. In the case of tuberculin (*see* p. 695) the vaccine consists of an extract of the dead bacilli.

Sensitized vaccines are sometimes used. They are vaccines in which an emulsion of the micro-organisms is left in contact for several hours with the serum of an animal immunized against the same micro-organism. The micro-organisms attract to themselves the specific antibody in the serum, they gradually sink to the bottom of the vessel, the serum is pipetted off, and we have left a vaccine to which is attached a specific antibody. It is called a sensitized vaccine. Like other vaccines, it is killed before use by heat or the addition of a little carbolic acid. Some authorities consider sensitized vaccines more useful than ordinary vaccines.

If the patient is severely and recently ill with a high temperature he is usually so considerably poisoned by the bacteria or their toxins which are causing his disease that the administration of a vaccine will only make matters worse, hence they should not be used at all, or at least in very small doses; but if the disease has lasted some time much good may sometimes be done by giving a vaccine which presumably acts by raising the various means of resistance to the micro-organism causing his disease. The attempt has been often made to use frequent estimations of the opsonic index (*see* p. 696) as a guide to the desirability of giving a vaccine, to the dose required, to the repetition of the dose, and to the progress of the case, and in the hands of highly trained observers the opsonic index may be a guide; but the fallacies in the estimation of it are numerous and in any particular case the observations should be made by the same skilled observer under similar conditions. The general condition of the patient—his temperature, pulse, and gain in weight—are also indications, and usually sufficient indications, as to whether vaccine treatment should be continued. Owing to the harm that may follow from a severe

negative phase (*see* p. 697) several days' interval must always elapse between the administration of each dose of vaccine, and a patient is usually much more likely to benefit if the vaccine is prepared from the actual offending micro-organism derived from him rather than from a stock cultivation of the same variety of micro-organism.

Many cases of long-continued suppuration, *e.g.* an empyæma, the pus of which is being coughed up, may be much benefited by the use of a vaccine. Usually some variety of streptococcus is present in the pus, and from this variety the vaccine is prepared. The initial dose for an adult is 5 to 20 millions. The worse the general condition of the patient the smaller should be the initial dose. Unless the negative phase is being observed by reliable observation on the opsonic index, a second dose should not be given until seven days have elapsed. The cases which do best are those in which there is a single abscess. If the infection is general, *e.g.* severe pyæmic, with multiple abscess, or malignant endocarditis, there is little hope that good will follow the use of vaccines. If more than one pathogenic micro-organism can be cultivated from the pus, a vaccine prepared from each may be used.

Tubercular Serums and Vaccines.—(Not official.)

Maragliano, Marmorek, and many others have attempted to make antitubercular serums which shall be as beneficial to those suffering from tubercle as antidiphtheric serum is to those suffering from diphtheria. None of these serums are sufficiently valuable to have come into general use.

Koch found that by growing tubercle bacilli under certain conditions, the fluid in which they grew contained their toxins. He called the fluid remaining after the bacilli were filtered off tuberculin, now usually called old tuberculin, the abbreviation for which is T. It is virtually a solution of the toxins in the glycerin in which the bacilli grew. It is a thick dark yellow fluid.

No effect follows if this is injected into a healthy person, but if he has a tubercular disease, the injection produces a high temperature, rigors, a feeling of illness, pains in the joints, sometimes albuminuria and rashes on the skin, and at the same time the tubercular lesion is stimulated into activity. These dangerous results forbid the use of this tuberculin for man; the only disease for which its employment might be justified is lupus of the skin, for there the local reaction in the lesion can be watched, and lupus is so chronic that some-

times the stimulation may be useful; but tuberculin is rarely employed even for lupus.

As the febrile reaction only occurs when the injected subject has tubercular disease, tuberculin is often injected into cattle to see if they are tuberculous, but its use for this purpose is unjustifiable in man.

Koch also prepared an aqueous extract of dried highly virulent tubercle bacilli. He called the upper layer of this extract, Tuberculin O., or shortly T.O. (Oberer Tuberculin). It is rarely used, and its action is the same as that of old tuberculin. The lower layer is dried and re-extracted several times; the final extract is called new tuberculin, T.R. (T. Rückstand). It produces no visible effects upon healthy people, but when injected in any but minute doses into those suffering from tubercle it leads to the same general reaction as old tuberculin, but usually produces no local reaction upon the tubercular lesion. New tuberculin is rarely used for diagnosis in cattle, and should never be used for this purpose in man. It is the tuberculin most used therapeutically in man, but a bacillary emulsion (B. E.) is sometimes given. Neither has been proved to have a beneficial therapeutic effect for tubercular disease, but some consider either useful for chronic varieties; but they can hardly be said to have proved this. Many think tuberculin often does harm, and unless used with judgment it may produce undesirable general reaction, and speaking generally tuberculin is not now thought to have the high therapeutic value formerly attributed to it. If not carefully prepared it may contain living tubercle bacilli.

Wright and others claim that tuberculin injections are beneficial provided that the opsonic power of the blood is watched. Opsonins are bodies contained in the serum of the blood; they so modify bacilli as to render them an easy prey to phagocytes. The strength of the blood in opsonins which thus modify tubercle bacilli is tested by mixing in a capillary pipette an equal quantity of the blood serum, an emulsion of tubercle bacilli, and blood corpuscles washed with one per cent. sodium citrate solution in normal saline. The mixture is incubated for twenty minutes, films are made. The average number of tubercle bacilli ingested by each polynuclear white corpuscle is calculated and contrasted with the number thus ingested when healthy blood serum is used. This latter is taken as unity, and the opsonic index is the ratio of the number ingested when the blood serum of the tubercular patient was used compared with the number ingested when healthy serum was used. It is believed that when the patient has a high opsonic index he is more likely

to recover than when this is low. Wright injects either tuberculin R or a tuberculin he himself prepares, carefully sterilized. The dose is $\frac{1}{5000}$ mg. The first effect is to lower the opsonic power of the blood. This fall is slight in a healthy person, greater if he be the subject of tubercle; it is called the negative phase, and lasts about a week in a tubercular subject, much less in a healthy person. It is followed by a rise, and in two or three weeks the opsonic index is higher than before injection (positive phase). If a second injection is made during the negative phase much harm is done, because the patient's opsonic power is seriously reduced for a long time; but if a second injection is given during the positive phase his opsonic power is much strengthened. To treat a tuberculous patient with tuberculin his opsonic index is taken. If it is above normal, we conclude that he has already in self-defence raised the opsonic power of his blood against tubercle, and so vaccinating him at this stage with tuberculin will not do much good; but if his opsonic index is normal, or below normal (variations between 1·2 and 0·8 are within normal limits), we inject $\frac{1}{5000}$ mg. of tuberculin (or in other words vaccinate him with the vaccine tuberculin), take his opsonic index from time to time after, and during the positive phase give a second injection, and so on. As a rule the second injection is required three weeks after the first, and the third three weeks after the second. Tuberculin, like other vaccines, is often given without observations of the opsonic index (*see* p. 694); if so, sufficient time must be allowed between the doses to avoid the negative phase. Some think that this treatment is of use in phthisis, many think it useless, and some believe it to be harmful; it occasionally appears to aid the cure of local tuberculosis, especially that of the bladder, skin, and lymphatic glands. If too large doses are given, or if a subsequent dose is given during a negative phase, we see the same evil effects that were observed when tuberculin was first employed by Koch. Lately tuberculin has been given both by the mouth and rectum, but this is probably useless.

Plague Vaccine.—(Not official.)

An emulsion of dead plague bacilli (Bacillus pestis) artificially grown in broth, originally prepared by Haffkine, has been largely used to vaccinate those exposed to plague. Those thus vaccinated rarely contract plague when exposed to it, especially if they have had two inoculations, and if they suffer from plague the attack is less severe.

Cholera Serum and Vaccine.—(Not official.) This serum is of no therapeutic value, but there is evidence that vaccination with cholera micro-organisms affords some protection. The only vaccines used largely are those prepared by Haffkine. They may be used for those about to go to a place where an outbreak of cholera exists, but not for those already in the midst of an outbreak, because for a time it renders those inoculated more susceptible.

Typhoid Serum and Vaccine.—(Not official.) There is no evidence that the serum treatment of typhoid fever is of benefit.

Wright has perfected a method of vaccination or inoculation against typhoid fever by injecting dead typhoid bacilli subcutaneously or intramuscularly with all antiseptic precautions. They are usually injected into the abdominal wall or the upper part of the arm. The dose is 500 millions. Local inflammatory reaction with some pyrexia follows in a few hours, but usually soon passes off. Therefore it is best to give the injection in the evening and keep the patient in bed the next day. A second vaccination of 1000 millions is usually performed ten days after the first. The blood serum of an inoculated person clumps typhoid bacilli for at least six months after an inoculation, and these inoculations render those inoculated much less susceptible and lower the rate of mortality among those who, although inoculated, acquire the disease. Inoculation should not be practised upon those in the midst of an outbreak of typhoid fever, because for a short time after inoculation the susceptibility to typhoid is enhanced. But those going to a country where typhoid is rife should be inoculated before going. All soldiers should be inoculated before a campaign.

Vaccines against Paratyphoid (A) and Paratyphoid (B) have been prepared and may be used for the prevention of these diseases just as typhoid vaccine is used. It is usual now to give a mixed vaccine against all three. The Great War showed the immense benefit of this.

Hydrophobia Vaccine.—(Not official.) A rabbit is inoculated from the spinal cord of an animal dead of hydrophobia, other rabbits are inoculated from the spinal cord of this, and so through a series until the spinal cord (which is the chief seat of the virus in hydrophobia) contains a virus the incubation period of which is seven days. The spinal cord loses its virulence when exposed to the air, so that a series of spinal cords (each of which originally contained a virus the incubation period of which was seven days) can be

prepared of greater or less virulence according to the time during which they have been exposed to the air. It is found that if a patient who has been bitten by a rabid dog is inoculated first with a rabbit's spinal cord of a low degree of virulence, and next day with one of a higher degree, and so on increasing the virulence of the injection, hydrophobia does not usually develop in him if the treatment is begun soon after the bite. The most convenient place (for the inhabitants of Great Britain) where the treatment is carried out is the Pasteur Institute in Paris, and if the person bitten go immediately after the bite it is almost certain he will not suffer from hydrophobia. The incubation period of hydrophobia is fortunately several weeks, and hence if the above treatment is carried out it renders the patient immune before the incubation period expires.

Staphylococcal Vaccine.—(Not official.)

This consists of dead staphylococcal bacilli; it is one of the most useful vaccines, and is employed for diseases, generally suppurative, due to staphylococci. Boils and acne are often cured by the administration of a vaccine made from the staphylococci in them. The dose, usually given in the same way as the typhoid vaccine, is 50 to 200 millions. If a fortnight is allowed to elapse between each dose, it is hardly necessary to take the opsonic index.

Colon Vaccine.—(Not official.)

Many febrile disorders, *e.g.* certain cases of cystitis, pyelitis, ulcerative colitis, and even suppuration in the chest, are due to the bacillus coli communis. They may often be strikingly benefited by the use of a vaccine prepared from the patient's own variety of colon bacillus. The dose usually varies from 5 to 50 millions, and several doses at about a week's interval are usually required.

Gonorrhœal Vaccine.—(Not official.)

This is very useful for chronic gleet and chronic gonorrhœal arthritis and rheumatism. As in so many other instances an autogenous vaccine is preferable to a stock vaccine. It is given in the same way as the colon vaccine. The first dose is usually 2½ millions, subsequent doses are 5, 10, and 25 millions.

A pneumococcal vaccine has been employed in some cases of pneumococcal infection. The general principles mentioned under the heading of streptococcal vaccine apply to all other vaccines. They often fail in cases in which much

was hoped from them—the reasons why this should be so are too numerous to detail here—but on the other hand they frequently succeed in intractable cases which have resisted all other treatment, and as, when properly used in chronic infections, they hardly ever do harm, they may well be tried together with, if necessary, other appropriate treatment, *e.g.* local treatment of pyorrhœa.

Lately vaccines of *Micrococcus catarrhalis*, pure or mixed with vaccines prepared from other micro-organisms from the nose and throat, have been given to prevent a common cold; and vaccines of micro-organisms from the throat and nose have been employed with the object of lessening the liability to influenza.

Yeast.—(Not official.)

The opsonic power of the blood may be increased by giving yeast. The dose is 5 to 10 grammes in milk. As with tuberculin, so with yeast, the first effect is a drop in the opsonic index; the drop is followed in a few days by a rise. An increase in the leucocytes of the blood also follows quickly giving yeast. It is not known to what constituents these effects are due, but it has been suggested they are due to the nucleic acid in the yeast. Boils are sometimes successfully treated by the administration of yeast; perhaps then the opsonic power of the blood in regard to the micro-organisms causing the boils is raised by the yeast, or it may be that the value of yeast is due to the large amount of vitamine B it contains. Nucleic acid, as it stimulates the formation of white cells in rabbits, has been given in various bacterial diseases and also by surgeons before serious abdominal operations, in order that the larger number of leucocytes should help to defend the body against micro-organisms which may cause acute peritonitis, but it seems to do but little good in man. Nucleic acid is best given subcutaneously in doses of 15 ♏ (1 mil) of a 5 per cent. solution of the sodium salt. It is sometimes called nuclein, a name also given to the residue obtained by the extraction by acids of pus, yeast, or spermatozoa. This residue contains much nucleic acid. For the nucleic acid derived from the thymus *see* p. 673.

APPENDIX No. I.

A LIST OF LATIN PHRASES COMMONLY USED IN THE WRITING OF PRESCRIPTIONS.

aa.	Ana	of each.
Ad.	Adde	add.
Ad lib.	Ad libitum	to the desired amount.
Ad us.	Ad usum	according to custom.
Æq.	Æquales	equal.
Aq.	Aqua	water.
Aq. bull.	Aqua bulliens	boiling water.
Aq. dest.	Aqua destillata	distilled water.
Bib.	Bibe	drink.
Bis ind.	Bis indies	twice a day.
Bis in 7 d.	Bis in septem diebus	twice a week.
C.	Cum	with.
Cap.	Capiat	let him take.
C. m.	Cras mane	to-morrow morning.
C. m. s.	Cras mane sumendus	to be taken to-morrow morning.
C. n.	Cras nocte	to-morrow night.
Cochl.	Cochleare	spoonful.
Cochl. ampl.	Cochleare amplum	a table-spoonful.
Cochl. infant.	Cochleare infantis	a tea-spoonful.
Cochl. mag.	Cochleare magnum	a table-spoonful.
Cochl. mod.	Cochleare modicum	a dessert-spoonful.
Cochl. parv.	Cochleare parvum	a tea-spoonful.
Contin.	Continuetur	let it be continued.
Cuj.	Cujus	of which.
C. v.	Cras vespere	to-morrow evening.
Cyath.	Cyathus	a glassful.
Cyath. vinos.	Cyathus vinosus	a wine-glassful.
D.	Dosis	a dose.
d.	Da	give.
D. d. in d.	De die in diem	from day to day.
Det.	Detur	let it be given.
Dieb. alt.	Diebus alternis	on alternate days.
Dim.	Dimidius	one half.
Div.	Divide	divide.
D. in p. æ.	Divide in partes æquales	divide into equal parts.
Exhib.	Exhibeatur	let it be given.
F. or ft.	Fiat	let it be made.
F. h.	Fiat haustus	make a draught.
F. m.	Fiat mistura	make a mixture.
F. pil.	Fiat pilula	make a pill.
Gutt.	Gutta or guttæ	drop or drops.
Habt.	Habeat	let him have.
Hor. intermed.	Horis intermediis	at intermediate hours.
H. s.	Horâ somni	at bedtime.
Ind.	Indies	daily.
Lat. dol.	Lateri dolenti	to the painful side.

Mit.	Mitte	send.
Mod. præscript.	Modo præscripto	in the manner directed.
Oct. pars	Octava pars	an eighth part.
O. m.	Omni mane	every morning.
Omn. bih.	Omni bihorâ	every two hours.
Omn. hor.	*Omni horâ*	*every hour.*
O. n.	Omni nocte	every night.
P. or pt.	Perstatur	continue.
Part. æq.	Partes æquales	equal parts.
P. r. n.	Pro re natâ	when required.
Q. l.	Quantum libet	as much as is requisite.
Q. s.	Quantum sufficit	a sufficient quantity.
Q. v.	Quantum volueris	at will.
Quart. pars	Quarta pars	a quarter.
℞.	Recipe	take.
Rep.	Repetatur	let it be repeated.
Sing.	Singulorum	of each.
Sum.	Sumat or sumendum	let him take or let it be taken.
T. d.	Ter in die	three times a day.
T. e quat. part.	Tres e quattuor partibus	three quarters.

APPENDIX No. II.

ALTERNATIVE PREPARATIONS SANCTIONED FOR USE IN TROPICAL, SUBTROPICAL, AND OTHER PARTS OF THE BRITISH EMPIRE.

Aquæ Anethi, Anisi, Carui, Cinnamomi, Fœniculi, Menthæ Piperitæ, Menthæ Viridis. —Each of these waters may be prepared by triturating the corresponding oil with twice its weight of calcium phosphate and 500 times its volume of distilled water and filtering.

Emplastra.—More or less hard soap, resin, or yellow beeswax, may be employed in the preparation of these in the text of the Pharmacopœia when prevailing high temperatures render the basis too soft for convenient use; but the official proportion of the active ingredient must be maintained.

Extracta Liquida.—Any Pharmacopœial liquid extract containing less than $\frac{1}{4}$ its weight of alcohol (90 per cent.) may have the proportion increased to an amount not exceeding $\frac{1}{4}$ when otherwise the preparation would be liable to ferment.

Limonis Cortex Siccatus.—If fresh lemon peel cannot be obtained, dried lemon peel may be used in preparing compound infusion of orange peel, compound infusion of gentian, syrup of lemon and tincture of lemon.

Oleum Olivæ.—In India, and in the Eastern, African, Australasian, and North American Divisions of the Empire, arachis oil or sesame oil may be employed in making the official liniments, plasters, ointments, and soaps, for which olive oil is directed to be used.

Suppositoria.—More or less white beeswax, according to prevailing temperatures, may be used in place of an equivalent amount of oil of theobroma where otherwise the Pharmacopœial suppositories would be too soft.

Syrupus Rhœados.—If prevailing high temperatures render this liable to ferment, the proportion of alcohol (90 per cent.) may be increased, but not to more than double the proportion stated in the Pharmacopœia, an equivalent quantity of distilled water being omitted.

Unguenta.—More or less benzoated lard, prepared lard, benzoated suet, yellow beeswax or white beeswax, may be employed in the preparation of the Pharmacopœial ointments when prevailing high temperatures render the basis too soft for convenient use; but the official proportion of the active ingredient must be maintained.

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